POWER

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ELY C. HUTCHINSON, *Editor*

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Purchasing Ethics

He was high in the councils of the Amalgamated Machinery Buyers' Association and spent many of his waking hours in the promotion of high ideals and tip-top ethical purchasing standards for the edification of the newspapers and guidance of the membership of his revered order.

A man of discernment sat at his office elbow one day and heard one side of a telephone conversation something like this:

"Yes they are all in . . . No you're not . . . Wait a minute. (Reaches for price tabulation on desk) . . . About seven per cent. . . . I'll wait until tomorrow noon . . . Not at all; that will be *all right.*"

One guess as to what was said at the other end of the line is probably all that is needed. And there is a moral to this. May we be delivered from those who talk from the corners of their mouths and given into the keeping of those who practice what they preach.

EDITORIALS

Turbine Performance

Large turbines are continuing the improvement in operating reliability that has marked the past few years. The turbine report of the N.E.L.A. Prime Movers Committee, which analyses the 1930 operating records of 324 turbines of 20,000 kw. and larger capacity, indicates a total unit outage factor of 9.17 per cent, the lowest yet reported. Outages caused by turbine troubles fell to 4.44 per cent from 5.02 per cent in 1929, 5.73 per cent in 1928 and 7.29 per cent in 1925.

Except for annual overhaul, blading is still the greatest single cause of turbine outage. The decreasing amount of this trouble is, however, encouraging. In 1930 only 8.72 per cent of the total turbine outage was due to bucket and blade troubles, while in 1929 outage from this cause was 17.2 per cent and 18.71 per cent in 1928.

This year's report shows, for the first time, the performance of ten turbines operating at pressures of 1,000 lb. or above. The relative inexperience with these units is reflected in the high turbine outage factor of 10.68 per cent. From statements by operating companies it may be inferred that a large part of this outage was caused by the fouling of turbine blades with salts carried over from the boilers.

That still better turbine performance should be expected is evidenced by the unusually good operating record of six units ranging in capacity from 15,000 to 30,000 kw. and having had one to seven years of service. These units have an average low total outage factor of 2.56 per cent. All but one of them operated all of the time, and they were available at practically full load or overload. Ths performance constitutes a record the utilities should be proud of.

The Power-Cost Trio

When purchasing power opportunities for reducing cost are not realized as often as they might be. Power rates generally include both a kilowatt-hour and a maximum-demand charge; also, they may vary according to a load power-factor schedule. To reap full advantage of the opportunities for reduced power bills each of these items requires study.

Kilowatt-hour consumption is influenced by many factors, but it should be remembered that large losses in the system, direct or indirect, can exist without seriously interfering with operation.

Maximum demand is generally affected by a different set of factors than is kilowatt-hour consumption. The kilowatt-hours used may be kept low when the maximum demand is high. A high peak once a month will cause a large increase in the power costs for that period. High peak loads may be avoided by placing a limit on the maximum demand and providing automatic means to keep it within that value and by arranging the process operations to prevent peaks occurring simultaneously. Changes have been made in operating procedure that have saved thousands of dollars per year in power bills without slowing-up the processes.

Rearrangement of the motors in a plant to have them more nearly loaded, the use of synchronous motors and the application of static condensers offer opportunities of reducing power costs by improving power factor. Recent improvements made in synchronous-motor design have greatly extended their use and the possibilities of obtaining a good power factor with alternating-current loads. Many plants that have taken advantage of these changes now are operating with a power factor around unity whereas a few years ago their power factors were so low as to incur a penalty in the power rate.

When considering ways of cutting costs, the power trio—kilowatt-hours, maximum demand and power factor—deserve careful study. Such investigations have revealed large loss in the form of unnecessary power costs where they were least expected.

Industry's Responsibility to the Stable Worker

In an address before the First Conference of Smaller Industries, some weeks ago, which was printed in *Mechanical Engineering* for October, J. W. Hook, president of the Geometric Tool Company, set forth some ideas concerning industry's responsibility during times of serious depression to those employees whom he calls "stable workers." He also indicates a possible plan whereby industry would meet this responsibility just as it meets the obligation of its bonded indebtedness.

The result of studies made on this particular business indicates that this stable employee group could have been kept working at nearly normal time and money during the depression by the setting aside of reserves amounting to only three-quarters of one per cent of the payroll for the years 1923 to 1929.

Application of this plan to other industries, however, requires the determination of who are the stable workers, and what additional reserves would be required.

Whether the stable worker should be concerned only

with production or whether the competent worker engaged in development should also be included is an open question. The electric utility industry, for example, has experienced a consistent growth for a number of years at rates varying from ten to fifteen per cent increase per year. It has employed large numbers of workers to engineer, superintend and construct the increase in structure necessary to meet this increased growth. Although comprising an appreciable percentage of the employees, workers of this type, whether used for design or construction, or for the development of new properties, have usually been taken on and laid off as needed.

It is considered a prime essential of conservative business administration to set aside large reserves from gross earnings to insure the fulfillment of financial obligations. Such reserves are used for interest payments on and retirement of bonded indebtedness, and other promissory obligations, as well as the replacement of worn-out and obsolete plant equipment and other requirements necessary to insure the continuity of business life. The results of the study in Mr. Hook's company, indicates the possibility that the addition of reserves, relatively small compared to those now set aside, might enable industry to meet its employee obligations in a similar manner.

Does the Purchase Of Power Save Fuel?

While industrial advantage rather than national conservation normally determines the purchase of power, the effect of buying or making upon national coal consumption is of interest.

In this connection it is well to examine the claim that central generation of power is responsible for a great saving in fuel.

Undoubtedly this is true as a general statement. Some may, however, draw from this the unwarranted conclusion that the nation's coal consumption is lowered each time a load is transferred from a factory plant to a central station.

Where power only is generated in the industrial plant it is almost universally true that a shift to purchased power will replace the plant's coal consumption by a smaller consumption of coal at the central station. This holds even after allowing for a 25 per cent transmission loss on purchased current.

Where power is generated purely as a byproduct, on the other hand, the coal chargeable to power is less than one-half-pound per kilowatt-hour as against about two pound per delivered kilowatt-hour of utility current. In such a case each kilowatt-hour shifted from the industrial plant to the central station would increase the national coal consumption about one and a half pound.

The typical industrial plant generates only part of its power as a byproduct. Therefore, the net coal consumption per kilowatt-hour is substantially greater than half pound, although in many cases still less than that of power delivered by the utility.

Admittedly, this discussion of coal consumption is somewhat academic from the viewpoint of the plant operator. He is interested not so much in national conservation as in obtaining power for the lowest overall cost, considering not only fuel, but investment, labor, etc.

The Challenge Of Facts

A half century ago there taught at Yale one William Graham Sumner. His fame extends to this day. Economics was his work. Though buried in an academic atmosphere, Sumner had the look and bearing of a big business executive. More important, he brought to his classes and to his writings a viewpoint more practical than that of many a high executive of modern business.

For Sumner believed in facts. He, far beyond most men, insisted that all gay dreams and bright ideas be tested in the crucible of workability. In the "Challenge of Facts" and other essays he drove straight to this point and expressed his contempt for the many who avoid facts in politics and in daily life.

Sumner stood aside from the stream of business, yet he would have made a masterful business executive. More men of this type were needed then and are needed now.

If Sumner had been controlling a business in 1928 or 1929, he no doubt, would have been ready for a break in the market followed by a general decline in business. The facts of business history would have made him beware. Likewise, today, when the wildest optimists of '29 are most deeply depressed, Sumner would again keep in mind the fact that slumps have always been followed by periods of good business.

Had he expected to stay in business he would conduct his operations with a long-time view and not unnecessarily hoard a dollar this year if it would set him back two dollars in the long run.

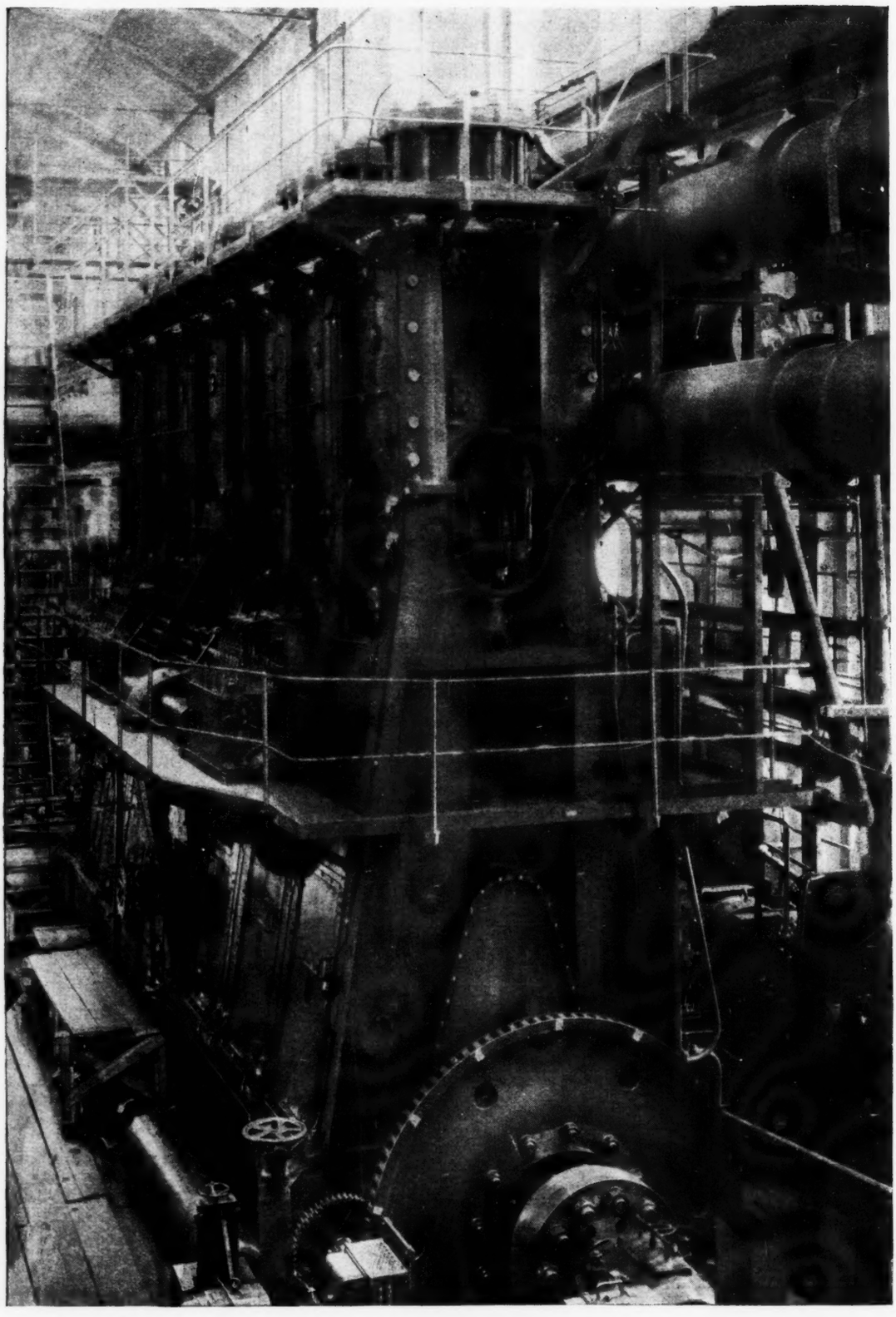
If a certain machine in his factory were wasting incessantly, he would inquire whether its replacement now, rather than a year later, would set him ahead financially *in the long run*. If the answer were in the affirmative and the money were available, he would so act.

All this is very simple to men who see facts, but this kind of vision is not as common as one has been led to expect.

▼

POWER Stands for . .

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason



The largest airless-injection marine engine in existence. A two-cycle, double-acting, seven-cylinder, 700 x 1,200 mm. (about 27½ x 47¼ in.) developing 7,200 s.hp. at 113 r.p.m. and 8,640 s.hp. at 128 r.p.m., recently completed by the M.A.N. for a Japanese cargo ship

The Diesel Engine; A World Viewpoint

By Col. OLIVER F. ALLEN
Consulting Engineer
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Colonel Allen trained at the Johns Hopkins University, and was associated with the General Electric Co. and the International General Electric Co. for 22 years, or until 1929, a large part of this time being spent in Europe. During the war he was with the A.E.F. in command of a battalion of the 24th Engineers. For the past ten years he has specialized in diesel engines, recently returning from abroad, where he made an exhaustive investigation of developments in that type of prime mover. At present he has a consulting practice in New York.

"MARINE POWER PLANTS" is here discussed in the first of a series of articles dealing with the present-day development of the diesel engine at home and abroad. Few realize the extent to which oil engines are being fitted into the various fields of service where power is used. It is appropriate that this series start with the story of the marine oil engine, as up to the present it is in this field that the greatest development has taken place.

OTHER ARTICLES will tell the story of diesels in central stations, on rails, the portable diesel for temporary power service, and power units used on farms, by contractors, etc. Diesels on highways are of growing importance in their effect upon transportation and will also be discussed. Oil engines as auxiliaries to central power systems are increasing in popularity and importance, and, in addition, industrial plants will be interested in learning of diesel applications to their work.

PROBABLY no greater influence in the development of diesel engines has occurred than in the plans for the use of heavy oil engines in the air. Problems involving weight, power and dependability in this service will inevitably have direct application to stationary engines of the larger sizes. So what is going on in he design of heavy oil engines in the air will form an important part of this histo y.

THE SERIES will conclude with a discussion of the responsibilities of the American oil engine industry in keeping the United States abreast of the rest of the world in this important development.

REFERENCE is made to certain makes of engines and particular applications as typical, but the author wishes it understood that other makes and applications are equally typical.

AT THIS TIME, when so much is heard about idle ships and the lack of demand for both cargo and passenger capacity, one is prone to overlook the fact that a considerable part of the idle shipping is so obsolete that even in times of normal activity it could not profitably be employed in competition with modern equipment; that passenger vessels are getting larger and more luxurious for all classes of service; and that cargo ships are required of greater speed, even when not of greater tonnage.

James A. Farrell, as chairman of the recent convention of the National Foreign Trade Council, said, "Our foreign trade is increasingly dependent upon the services rendered by our American shipping. About 33 per cent in value, and about 40 per cent in volume of our foreign trade is carried in American bottoms." In 1850 1,422 vessels of 279,255 total gross tons were built and documented in the United States. From then until 1885 the number varied between 900 and 1,600 per year, with the gross tonnage from 157,000 to 297,000. This shows that United States shipping can compete with the rest of the world, as the editor of the United States *Nautical Magazine and Naval Journal* said in 1856, "One of the remarkable illustrations of our progress as a nation is to be found in the rapid and unparalleled increase of our mercantile marine. Our tonnage already exceeds that of any other nation, and at the ratio of increase

during the last 15 years we may, at no very distant period, boast of more shipping than England and France combined."

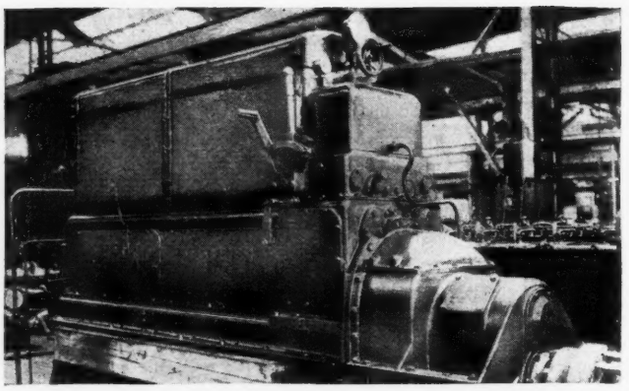
What is the situation now?

Neglecting the World War period and the years immediately following, as abnormal, and taking 1922 to 1930, inclusive, in only two years out of the nine have the ships built and documented in the United States exceeded 1,000 vessels and 1922 is the only year that the gross tonnage was over 600,000. Only one other year did it reach 300,000 and only five other years exceeded 200,000, while the 1929 total was 129,000.

In other words, while our industry as a whole has grown enormously, we are building no more ships than we were 50 years ago and their average size is only slightly greater. For the last nine years the average is only about 280,000 gross tons for all classes of vessels, while during the same period the British built, on the average 310,000 gross tons of motorships of over 1,000 tons. This has been at a steadily increasing rate from 115,000 tons for the first year to 744,000 in 1930. The gross tonnage of motorships completed in the world during these same years has risen from about 200,000 per year to over 1,000,000 tons each of the last three years. During the first six months of this year, 1931, over one hundred new motorships of more than 1,000 tons gross were placed in commission.

The importance of oil-engine-driven ships compared with steam-driven is shown by the fact that of the world tonnage (gross) under construction from March, 1923, to March, 1930, the ratio of motorships to steamers changed steadily from 11.5 per cent of the total to 59.5 per cent. In March of this year, due to the relatively large number of express liners being built with turbine drive, the percentage of motorships dropped to about 55 per cent.

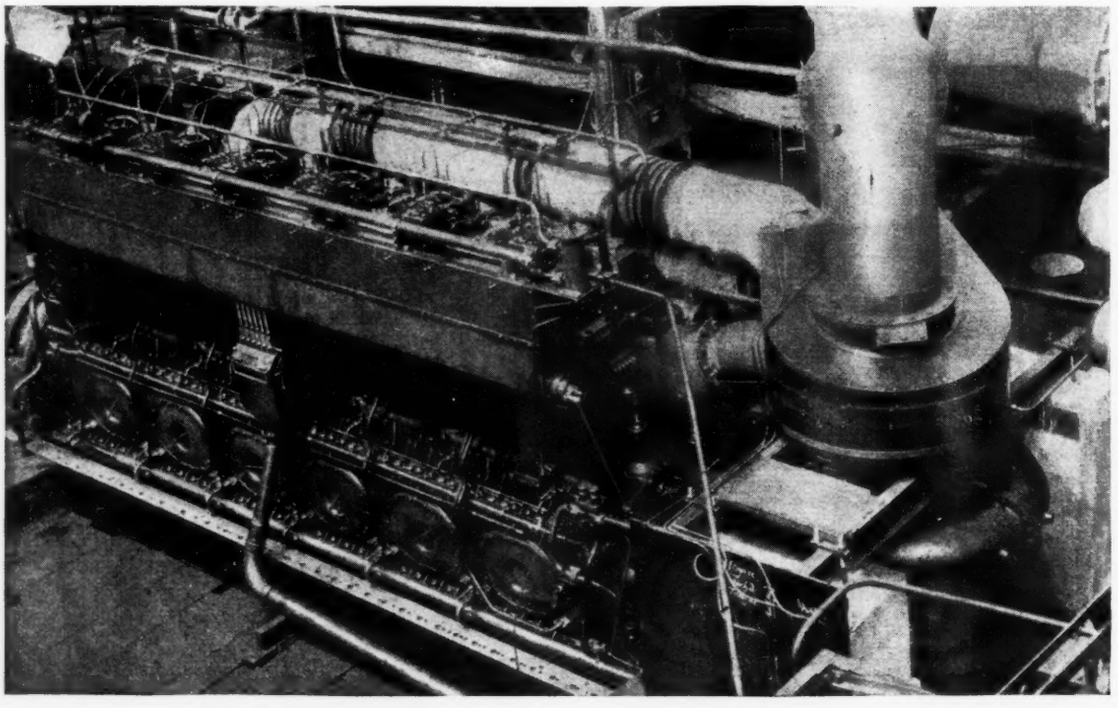
Why is it that the United States, which has made such wonderful progress in the development of machinery for rail and highway transportation, is now building less than 6 per cent in number and less than 3 per cent in horsepower of the marine oil engines now on order? Our situation as to marine steam turbines is much better. We are building over 40 per cent in number and over 25 per cent in horsepower of those under construction. We are leading as to number of units and rank next to Great Britain and Ireland in horsepower.



An example of gear drive for propeller. A Deutz six-cylinder, 200-hp., 600-r.p.m., four-cycle, airless-injection, direct-reversing marine engine with reduction gears attached to the main frame like an automobile gear-box

What is the marine power plant situation?

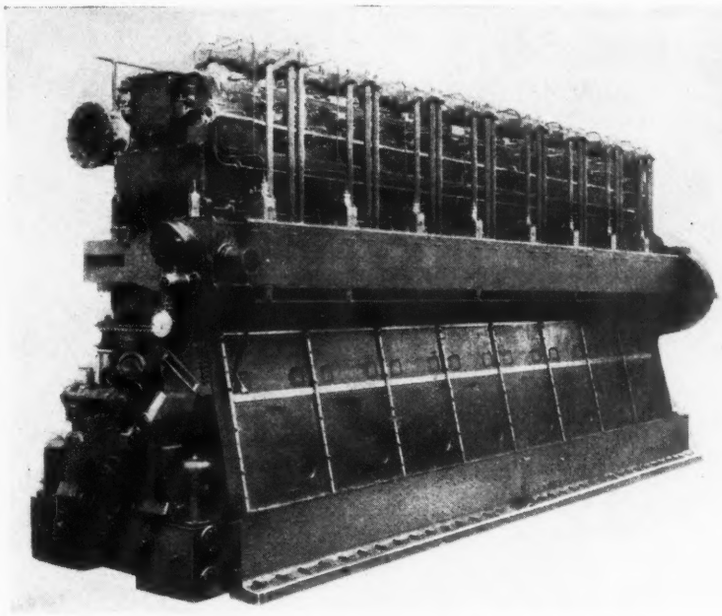
At the end of March, 1931, there were building, for marine propulsion, almost 900,000 horsepower of oil engines, of which we were making 20,000. In addition there are many thousands of horsepower of auxiliary plant and equipment of all sorts and kinds. A large part of these engines will carry American people and goods across the oceans and bring back our imports. The manufacture of that 97 per cent which we are not building does not help our unemployment problem or fill our empty shops. Let us look at some aspects of the up-to-date marine power plant.



A recent submarine application where the piping was greatly simplified and space saved, by making the exhaust-gas, turbine-driven blower unit with a vertical shaft. The output was increased by supercharging from about 1,100 hp. to 1,500 hp. and the fuel consumption reduced from 176 gr. (0.387 lb.) to 167 gr. (0.367 lb.) per brake horsepower-hour

The demand for more luxurious quarters and higher speeds for passengers and quicker delivery of freight by cargo boats emphasizes the increasing importance of the power plant. This must be considered from many angles, such as space which it takes in relation to pay space, its freedom from vibration, and its suitability for the particular service involved; also the most efficient propeller speed feasible and the best provision for the auxiliary services, as well as the very important problem of minimum fuel consumption and maintenance.

The power plant must be studied as a complete unit. It is recognized that there is still a field for the reciprocating steam engine, but a much greater field for the steam turbine. There is also a field, rather limited but still existing, for the gasoline engine, and again a much greater field for the heavy oil engine. The reciprocating steam engine and the gasoline engine do not require any particular attention, because their applications are well known.



An example of a large four-cycle, airless-injection direct-reversing marine engine. This M.A.N. engine has eight cylinders, and develops 2,950 hp. at 215 r.p.m. This type is also used for electric drive

For both the steam turbine and the heavy oil engine there are several drives which should be seriously considered. For both, the direct drive with prime mover operating at propeller speed is still being installed on large and important ships. This direct drive is diminishing rapidly in the case of the steam turbine, because it is so generally recognized that the reasonable requirements of space, weight and efficiency, demand turbine rotative speeds far in excess of those feasible for efficient propellers. This tendency is not as marked in the case of the oil engine, because even now the majority of oil engines employed for marine propulsion have a normal design providing for rotative speed acceptable to the propeller designer. There is, however, a very pronounced tendency toward rotative speeds higher than are feasible for propellers of any except very high-speed vessels, and the shipping industry is looking for means to speed up and so decrease the weight and cost of the oil engine, while retaining the low propeller speeds. Reduction in headroom now required for large, slow-speed oil engines is also an important factor.

This brings us to the next arrangement, which applies to both the steam turbine and the oil engine, namely, gear drive. The use of gears for reducing steam-turbine speed became quite general about fifteen years ago and has now become so standardized that it is employed for units of about 30,000 hp. each, in the new high-speed passenger ships of the North German Lloyd, and will be applied in larger units in the Cunarder now building at Clydebank. While gearing has been applied to internal-combustion engines for many years, its use for marine propulsion on any considerable scale is quite recent, and the important installations have been made during the last two or three years. These are of the order of 3,000 to 5,000 hp. compared with the larger gears just mentioned for the turbine, but bear about the same relation to the size of the diesel marine power plants as the turbine gears do to the steam plants. For instance, the largest merchant ship at present in service has a power plant developing about 120,000 hp. compared with the largest diesel plant of about one-fifth that size. The German battleship Ersatz Preussen, now nearly completed, has a 50,000-s.hp. plant of eight 6,250-hp., 450-r.p.m. diesels geared to the four propeller shafts.

The importance of this application is evident when it is realized that reduction gears with ratios up to the order of 10 to 1 are entirely successful with steam turbines, and it is therefore evident that ratios permitting the maximum speeds feasible in diesel design are also permissible, so that the oil engine manufacturer is now free to develop the highest-speed diesels he considers consistent with reliability, economy and low cost. Thus he can take advantage of less space, and especially of less headroom, which has been something of a restriction in the use of large diesels.

The third method of connecting the prime mover with the propeller is the electric coupling. This has been employed for both the steam turbine and the oil engine since the earliest days and has gradually increased in capacity and field of employment until it is now used with the turbine, especially in the United States, for some of the largest ships, both naval and merchant. More recently it is being employed in large ships of British manufacture. The diesel-electric drive has been applied for somewhat different reasons than the turbine. The turbine-electric drive has been largely employed as an efficient speed-reducing coupling combined with flexibility of arrangement and manipulation. In addition to these features, the diesel-electric drive has provided means for concentrating the power of several engines on one propeller shaft with a more efficient arrangement of space and greater freedom in selecting size and speed of the oil engines.

To a certain extent electric drive has been employed with both the steam turbine and the oil engine to meet peculiar conditions of operation, as for instance, in the case of naval vessels to provide efficient cruising speeds much below maximum speeds; also, for merchant ships, part of whose itinerary is through waters where high speeds are not feasible, or where a number of stops for commercial reasons must be timed for certain days and hours, to provide efficient operation at the lower speeds. In such cases electric drive permits cutting out certain

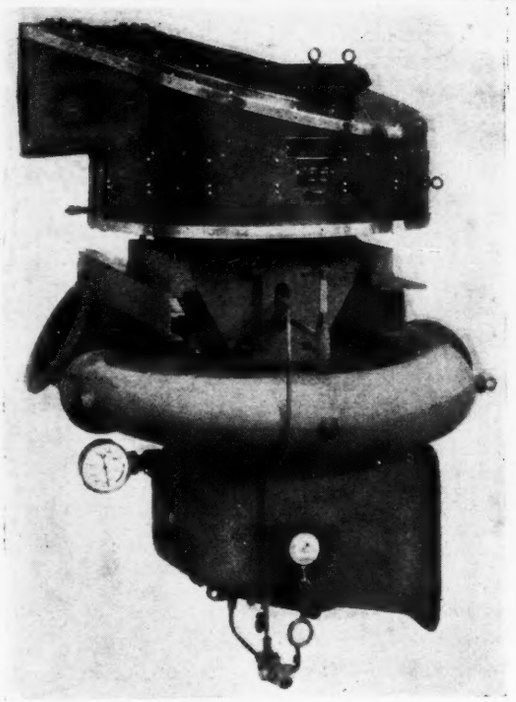
units, or operating all units at efficiencies that would not be possible with a definite reduction ratio between the prime movers and the propellers.

Electric drive, employing a multiplicity of engines, as for instance, four units of 750 hp. each for a 3,000-s.hp. single-screw tanker, offers economies of operation in smooth water with favorable winds with three engines running and one as a stand-by, at the same time providing units of reasonable size for the power requirements in port. This arrangement also offers abundant opportunity for overhaul by the crew when at sea, thereby reducing the time in port and saving what are frequently excessive charges for repair and maintenance work at dock. It has resulted, not only with electric drive, but with other types of oil engine propulsion, that many motor tankers are at sea as many as 300 days per year.

Following the general introduction of the oil engine for ship propulsion and the consequent lack of steam for auxiliary services, the electric motor auxiliary has become standard marine practice, and the modern ship, both passenger and cargo, has an auxiliary power plant very much larger than the corresponding vessel of a few years ago. The natural tendency was at first to have steam-driven auxiliaries on the turbine ships and oil-engine auxiliaries on the motorships. As the advantages of exhaust gas heaters have been better understood, part of the auxiliary service of motorships has gone back to steam or hot water, and, as the advantages of the oil engine auxiliary have been better understood, it has largely replaced the steam auxiliary in the turbine ships. For instance, how many passengers who cross on the Europa or one of the more modern ships of other lines, knowing that they are on a steamship, realize that diesel engines are furnishing all the auxiliary power? On the Europa, for instance, the auxiliary power requirements are about 4,000 hp., supplied exclusively by diesels.

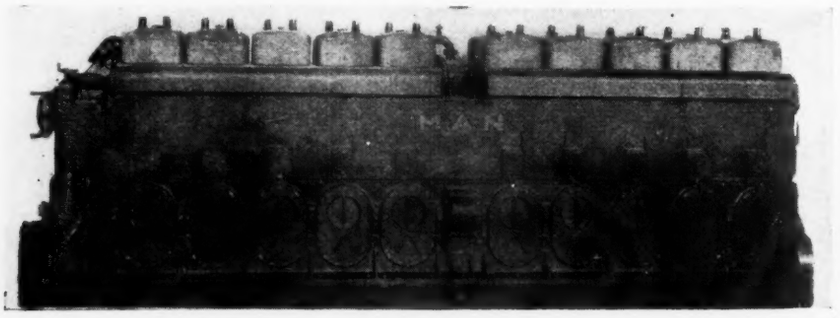
In such ships as the Europa, the diesel auxiliaries leave the main power plant free of all load requirements for the 15 or 20 hours that the ship is in port. Consequently the engine room staff can concentrate on the necessary maintenance work and leave the auxiliary plant to take care of the port power requirements of the ship.

The advantages and disadvantages of any particular type of drive should be studied with reference to the service to be performed. A similar study should be made as to the auxiliary machinery. The differences in cost of fuel, as well as its availability, capital charges and maintenance must all be evaluated. The outstanding thing is that both turbine drive and diesel drive are feasible for practically all classes of ships and that either type may be employed with a variety of drives. Also, a combination of the two offers many advantages for some classes of service.



One of the refinements which is being used more and more is the exhaust-gas turbo-driven supercharger for four-cycle engine. About 250,000 hp., supercharged output, of diesels using the Büchi system with Brown Boveri blowers have been equipped or are on order

The steam turbine has proved itself for the largest powers applied to marine propulsion. The oil engine has been successfully applied to many of the large moderate-speed passenger ships, such as the Augustus of the Navigazione Generale Italiana of 28,000 hp., the Lafayette of the French Line with 18,000 hp. in four engines, and the Victoria of the Lloyd Triestino with four engines of about the same capacity, which has attained a speed of 23¼ knots on trials, to say nothing of the White Star Brittanic and the Reina Del Pacifico for the Pacific Steam Navigation Company's Liverpool-Valparaiso service, each with over 20,000 hp. It is therefore apparent that in the opinion of responsible ship owners and operators the motor vessel and the steamship are now on an equal basis so far as the quality of service is concerned for ships not requiring over about 25,000 hp. and that the size of the motorship is constantly growing. It is equally apparent that for auxiliary service diesels are recognized as entirely satisfactory for the largest steamships.



An example of high speed, light weight and low headroom. A ten-cylinder, 1,000-hp., 700-r.p.m., four-cycle, airless-injection, direct-reversing marine engine, of a type also used for both electric and gear drive

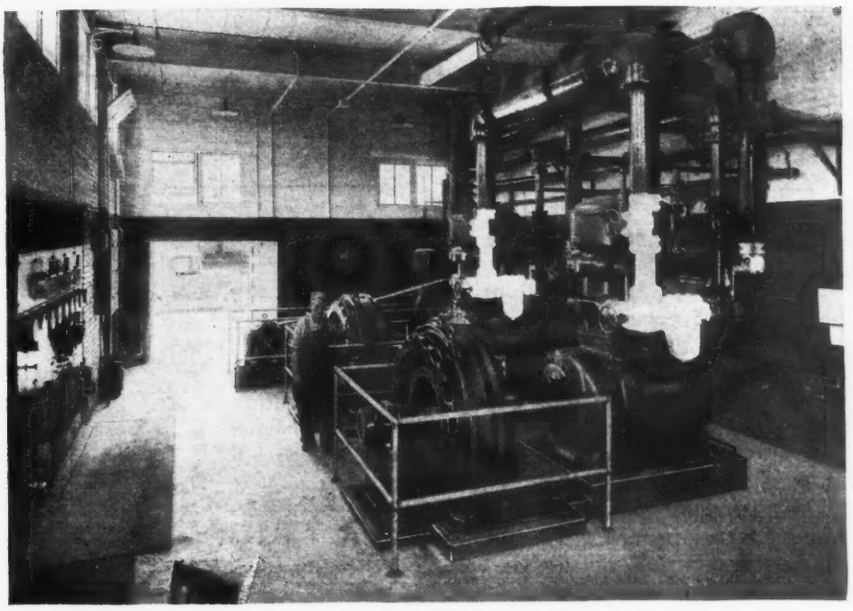


Fig. 1—Dual-pressure compressors in the Atlantic Ice and Coal Company's Knoxville, Tenn. plant

By W. R. KITZMILLER
Frick Company

Dual-Pressure Refrigeration Reduces Power Costs

MANY plant owners do not realize the saving possible over a straight ice plant with a relatively small investment in dual-pressure equipment. It is hard to estimate investment matters in a general way, since so many variable factors are present to throw results off, but one example cited farther on gives a fair comparison between the straight and dual systems. However, it is fairly simple to estimate accurately the saving in power, thus leaving the plant owner to balance this against interest and depreciation on the difference of cost of the two systems.

There may be cases where the dual-pressure changeover in present plants will not pay, but a fair comparison between the two will show good results in the plant using 85-deg. water for both ice-making and condensing purposes. New plants under consideration should be given careful thought, since an original installation can be accomplished much more economically than a revamped plant. In fact several types of dual-pressure plants can be installed for the same cost per ton as the straight compression plant.

There are two different styles of dual-pressure ice plants, one using the dual-effect machine, the other using two ordinary refrigerating machines. Both have two things in common, the cooling of can water and liquid ammonia at a high suction pressure. Ice is frozen at the normal temperature and suction pressure common to any plant. The difference lies in the fact that a dual-effect machine has ports in the cylinder wall, at the end of the piston travel, to admit this high-pressure gas, and thus handle both pressures with one machine. The two-machine installation has a compressor operating on each suction pressure.

It is questionable if there is a great deal of difference in the power required for operating these two styles of plants, but I am inclined to believe the dual-effect machine installation has the most favorable characteristics. One of the greatest differences is due to the fact that the high suction pressure of the dual-effect compressor cannot be controlled, but if the high-pressure machine of the two-machine installation is not equipped with capacity control the high suction pressure will vary with the load similarly to the dual-effect machine.

The high-pressure machine of a two-machine installation can be transferred to the low-pressure load in cases of emergency, but generally this machine is very small and would not be of much help. This machine can hold the tank temperature during shutdown periods when no ice is harvested, but each year modern plants are operated closer to design with less thought toward spare machines, and storages are generally taken care of automatically by circulating brine from the tank or a small automatic compressor. The high-suction ports of the dual-pressure machine will only admit gas at a pressure above the low suction, and this amount decreases rapidly as the two suctions tend to equalize.

Clearance control can be furnished on the low-pressure suction of the dual-effect machine, but not on the high-pressure. In the two-machine design, both the high- and low-pressure machines can be equipped with capacity control, but there is no great advantage in controlling the high-suction pressure, since several pounds' drop does not affect the saving in power materially. A decrease in the high-pressure load usually follows a small increase in the low-suction pressure, and generally the dual-pressure machine balances somewhere near its original design when the plant is operating at full capacity.

Plants using either of the two systems generally have several machines and then it is possible to handle part capacities in the high suction of the dual-effect machine

by operating only the number of high-pressure suctions required. One dual-effect machine has the correct capacity of high-pressure gas required for the work done at low suction when operating at the usual pressures employed for water and liquid cooling, and also for ice-making.

The dual-effect machines have several other advantages which might be enumerated, as follows: low first cost, smaller floor space, and only one set of losses in driving equipment. Slightly more headroom is required, but usually this does not add to the height of modern engine rooms. Many of the present-day dual-pressure plants are considering the dual-effect machine and many have already been installed.

The dual-effect compressor has a slight loss in the length of its stroke when uncovering the high-suction pressure ports, but again the high-pressure ports have a higher efficiency than the suction valves of a separate high-suction pressure machine. It is also possible that this loss in capacity should be credited with a corresponding saving in power when it is considered that this high-pressure gas is raising the pressure of the low-pressure suction without expending any energy in the form of mechanical work.

Regardless of the type of machine employed, the lay-out in Fig. 4 illustrates the dual-pressure system with either the dual-effect or the two-machine installation. The diagram shows water and liquid cooled at the high-suction pressure. The liquid cooler may be a simple shell with all the liquid in circulation passed through it and cooled by evaporation at the high-suction pressure; but a coil in the liquid cooler is preferred, since it is possible to maintain a higher and more constant pressure at the float valves. In the open type this liquid pressure depends on the high-suction pressure, while in the coil type the liquid pressure at the expansion valve depends on the condensing pressure.

In a coil-type cooler the liquid temperature approaches the high-suction temperature closely, since the transfer with this construction can be maintained high. The velocity of liquid through the coil and the size of the coil determine this transfer. There have been several instances where liquid left the coil at a temperature corresponding to the high-suction pressure.

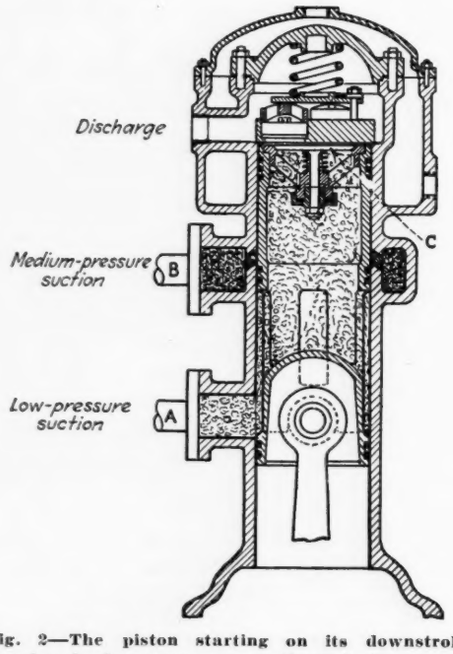


Fig. 2—The piston starting on its downstroke, drawing in low-pressure gas through the port A and the suction valve C mounted in the piston crown

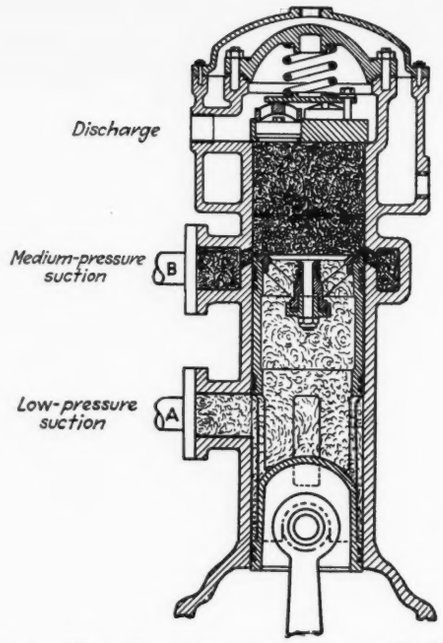


Fig. 3—When the piston uncovers port B, high pressure suction gas rushes into the cylinder compressing the low-pressure gas

Water coolers of the Baudelot, vertiflow or Udell types are the best for this purpose. The Udell cooler is meeting wide approval, for, due to its high efficiency, it generally fits in a small space. Water must usually be recirculated over or through these coolers, but by locating them on the roof in a small penthouse this cold water will drain to the can-filling tanks by gravity. Ice is frozen in the tank by brine cooled at the low-suction pressure. Here is another place where the operator does well in thoroughly considering the type of evaporator. Horizontal brine coolers with boiler tubes, and vertiflow units with pipe construction, present the two most efficient types. Since the vertiflow offers an evaporator that will not freeze up as readily as the brine cooler, it is often more acceptable. On the other hand, several large plants and many smaller ones installed brine coolers this year.

The saving previously mentioned over the one-suction-pressure ice plant can be better illustrated by a comparison of the theoretical horsepower of a dual-pressure plant with the same capacity one-pressure ice plant. The figures are based on producing one ton of ice. The horsepower is theoretical, as the per cent saving will be practically the same when based on theoretical or brake-horsepower. It is reasonable to expect the increase of brake-horsepower over the theoretical horsepower to be the same in each case. In fact, dual pressure should show less of an increase, for there should be lower friction losses.

The following assumptions will be made; water to cans, 85 deg. F.; water to condenser, 85 deg. F.; condensing pressure, 185 lb. gage; low-suction pressure, 20 lb. gage; horsepower, 42.4 B.t.u. per minute; and 12 deg. freezing temperature.

Working with these figures, the straight ice plant will give: $2{,}000 \times (85 - 32) = 106{,}000$ B.t.u. for water-cooling to 32 deg. F.; $2{,}000 \times (32 - 12 \times 0.5) = 20{,}000$ B.t.u. for ice-cooling to 12 deg. F.; and, $2{,}000 \times 144 = 288{,}000$ B.t.u. for freezing—making a total of 414,000 B.t.u. per ton. To this should be added 10

per cent for losses, bringing the total to 455,400 B.t.u. This is equivalent to $\frac{455{,}400}{288{,}000} = 1.58$ tons of refrigeration per ton of ice. The B.t.u. heat removal per pound of ammonia circulated with 20-lb. suction and 185 lb. discharge pressure will be 462.7 B.t.u. Consequently $\frac{200 \times 1.58}{462.7} = 0.683$ lb. of liquid will be circulated per minute per ton of ice. The adiabatic work required to compress the suction gas will be 111 B.t.u. per pound circulated, equivalent to $\frac{0.683 \times 111}{42.4} =$ 1.8 hp. per ton of ice.

The dual-pressure plant will be based on the same conditions previously shown for straight ice plants, with the addition of high-pressure suction. This will be based on 35 lb., although most dual-pressure plants operate as high as 40 to 45 lb., with correspondingly higher savings.

With the can water precooled to 35 deg. F. the tank work per ton of ice will be 355,400 B.t.u. This is equivalent to 1.23 tons of refrigeration per ton of ice. The ammonia circulated through the freezing coils will be 0.45 lb. per ton of ice per minute.

The precooling will call for the removal of 69.5 B.t.u. per minute per ton of ice made a day. To accomplish this 0.15 lb. of ammonia must be evaporated in the water cooler. To cool all the ammonia circulated in the system will require the evaporation of 0.0814 lb. of ammonia at 35 lb. gage per minute. The total weight of ammonia entering the compressor at 35 lb. gage will be 0.2314 lb. per minute.

The total horsepower of the dual-pressure system equals the total horsepower to raise the 20-lb. gas to 185 lb. and the 35-lb. gas to 185 lb. Compression work from 20 lb. to 185 lb. will be 111 B.t.u. per pound of ammonia circulated, and from the 35 to 185 lb. the work per pound will be 86 B.t.u. The horsepower, then, becomes $\frac{(111 \times 0.45) + (86 \times 0.2314)}{42.4} = 1.647$ per ton of ice.

This shows 8.5 per cent theoretical saving over the one-pressure ice plant. The dual-pressure system will give 8 to 10 per cent saving during the peak load occurring when the water temperatures are at their height and the plant is operating full capacity. The high-suction pressure will increase, with a correspondingly greater saving. Plants now operating have achieved these results. The latest data received from a large ice plant manufacturing some 250 tons of ice show that the over-all power used at present does not exceed 37.8 kw. per ton of ice. This power includes the total kilowatt consumption of the plant and represents approximately 10 per cent saving over straight compression. This is good; many plants are using 40 to 45 kw. at present. The design of equipment naturally effects efficient operation, and the above plant equipment represents the latest.

The plant owner will be wise in checking the dual-pressure system thoroughly before choosing his new ice plant equipment. Power cost plays a large part in the selection, along with investment. The cost per ton of ice for dual-pressure plants varies just the same as the other plants, but one installation now in operation cost approximately $675 per ton of ice for the refrigeration equipment. This same plant less the dual-pressure equipment would have cost about $655 per ton of ice. This is an increase of 3.1 per cent investment against a 10 per cent saving in the power bill. Several other plants installed the dual-effect equipment at the same cost per ton as straight compression, for machine capacities increase with liquid and water cooling, thus giving more ice from less machine investment.

In selecting equipment for a new plant, an accurate check can be made from a cost comparison of the straight ice plant and the dual-pressure before the equipment is purchased, but many opportunities are afforded in present plants. The previous figures will provide a ready check for these cases, and a plant survey will decide the advisability. After surveying present plants, it may be found that many pieces of equipment are adaptable to a dual-pressure system by merely rearranging.

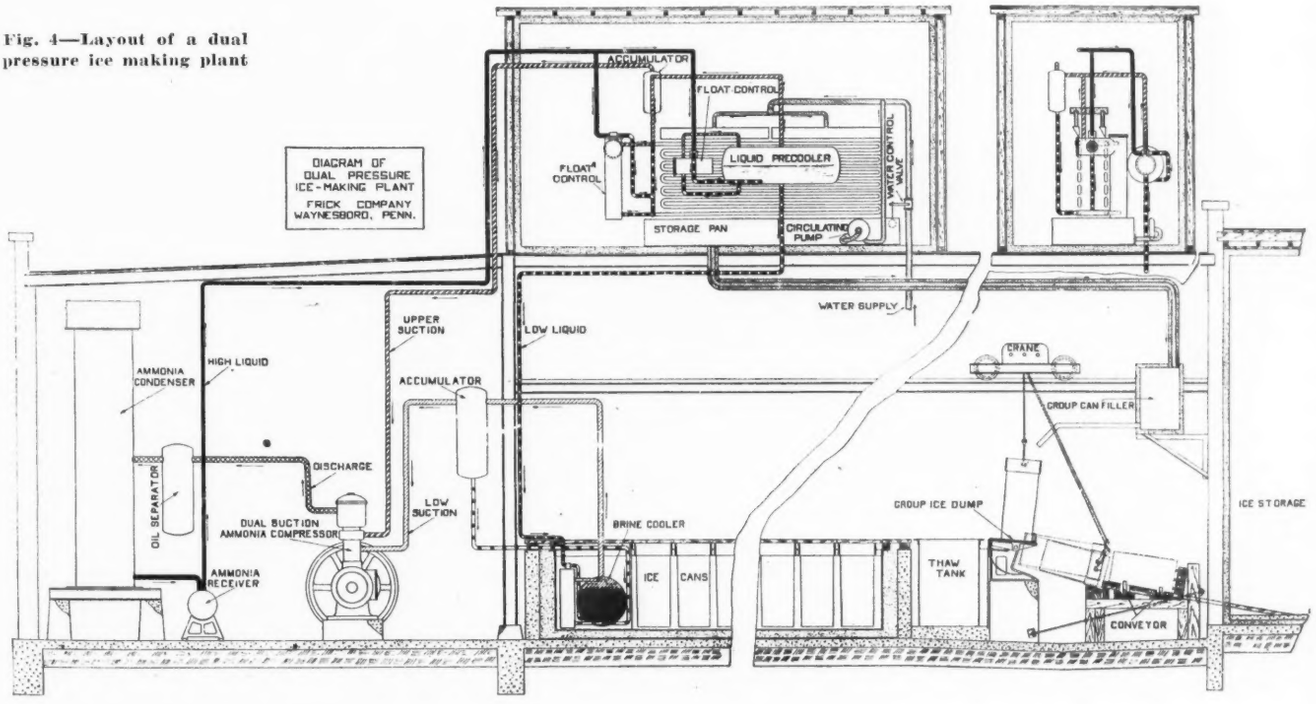


Fig. 4—Layout of a dual pressure ice making plant

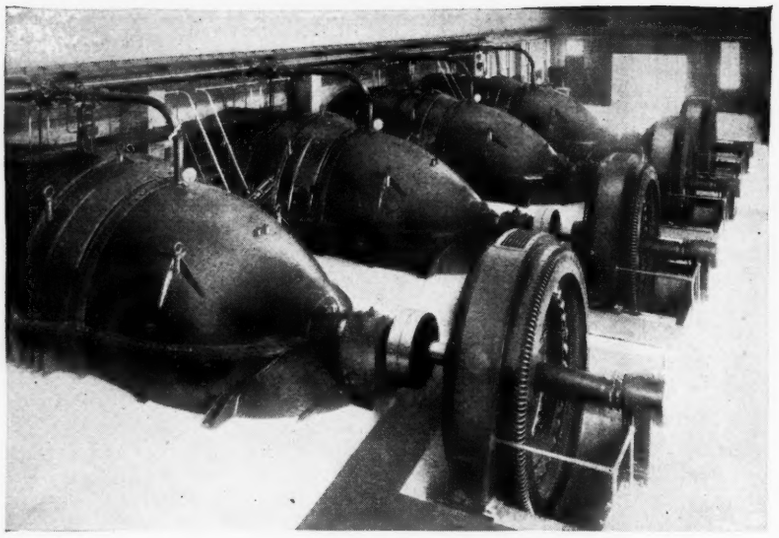


Fig. 1—Four 2,000-hp., 98.8-r.p.m. synchronous motors driving low-head pumps

By A. E. BEARDMORE

Industrial Engineering Department
General Electric Company

Synchronous-Motor Drive for Municipal Pumps

Operating characteristics and the installation costs of induction-type and synchronous motors are compared and the possibilities of reducing power costs by improving power factor are indicated. Typical synchronous-motor-driven municipal pumping installations are described

SYNCHRONOUS MOTORS with their high efficiency, unity or leading power factor, simple control combined with low first cost, and ease of operation, are ideal driving units for pumps in municipal pumping stations. A large portion of the load in the average municipal pumping station is continuous with only relatively small fluctuations at certain times in the day. If a storage reservoir is used, the rate of pumping may be held constant, and the variation in demand may be taken care of by the reservoir. When the demand changes sufficiently pumps may be started or stopped, to compensate for the changes.

Where a load is continuous the efficiency of the driving unit has a material effect on power cost. Synchronous motors, with their high efficiency, offer the best means of keeping down the power bill. An increase of one per cent in the efficiency of a 1,000-hp. motor will reduce the power bill $653 in a year of continuous operation where the power rate is one cent per kilowatt-hour.

In many cases electrical-service contracts have a power-factor clause offering a reduction in the power rate if the power factor is above a certain value, and imposing a penalty if the power factor is below the specified value. If auxiliary equipment requires many small motors, or if the main-pump motors are of the induction type and are underloaded, the power factor of the load is likely to be below the penalty limit unless some means of improvement is provided. If the percentage of power required by auxiliary motors is relatively small, using synchronous motors instead of the induction type will bring the power factor high enough to obtain the lowest power rate with unity-power-factor synchronous motors. If a greater amount of power-factor improvement is required than can be obtained with these motors, leading power-factor motors can be obtained for a slight increase in price.

Two typical power-factor clauses frequently incorporated in power contracts to favor loads having power factors approaching unity are given. The first is based on a certain rate per kilowatt-hour if the power factor is 85 per cent, with a decrease of ½ per cent in the bill for each one per cent increase in power factor above 85 per cent, and a corresponding increase of ½ per cent in the bill for each 1 per cent decrease in power factor below 85 per cent.

Another typical power contract starts with a base rate of 0.85 power factor. If the power factor is increased to 90 per cent, the bill is reduced 1.9 per cent; if the power factor is increased to 95 per cent, the bill is reduced 3.5 per cent, and if the power factor is made

unity the bill is reduced 5 per cent. If the power factor falls from the base of 85 down to 80 per cent, the bill is increased 2.3 per cent; if it falls to 75 per cent, the bill is increased 5 per cent; if it falls to 70 per cent, the bill is increased 8.3 per cent; and if it falls to 65 per cent, the bill is increased 12.5 per cent.

A plant having a total continuous load of 500 kw. at 1 cent per kw.-hr., based on 0.85 power factor, would have a bill of $43,800 per year. If the power factor of this load were improved to unity, the bill would be reduced 5 per cent or $2,190, while if the power factor dropped to 75 per cent, the bill would be increased to $2,190.

Assume that the latter power-factor charge clause is included in a contract for supplying power to a 2,000-hp. load and that a squirrel-cage induction motor was used instead of a synchronous motor. The induction motor would have a power factor of approximately 80 per cent. This would result in a loss of the bonus of 5 per cent given for unity power factor, and would also incur a penalty of 2.3 per cent because the power factor is 80 per cent, or 5 points below 85. This is a total increase in the power bill of 7.3 per cent due to the low power factor. A synchronous motor of the same rating would have an efficiency several points higher than the induction motor so that there would also be an increase in the bill because of the additional power used by the induction motor.

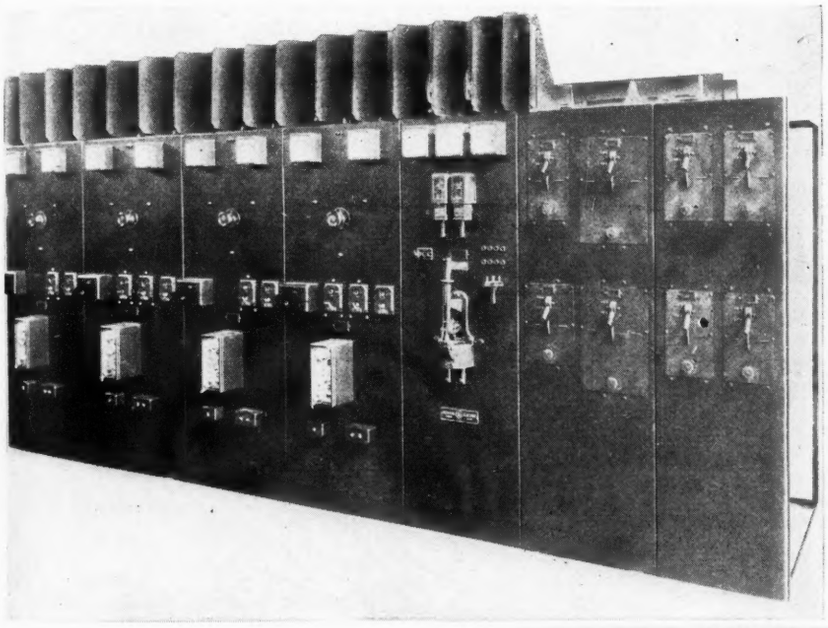
Automatic-Starting Equipment

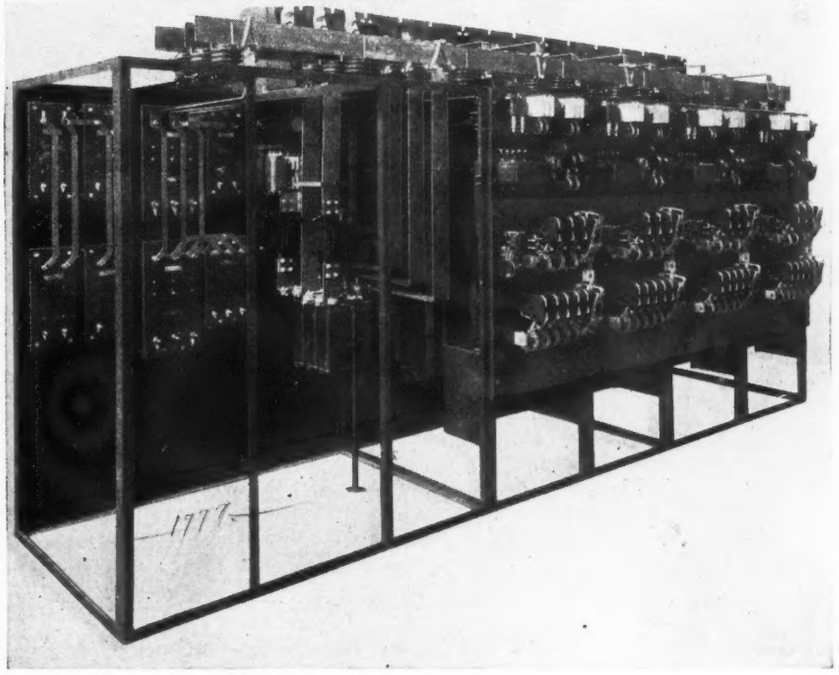
Automatic starting equipment reduces the starting or stopping operation of synchronous motors to the pushing of a button. If desired, the control can be arranged to start or stop the motor automatically by changes in water level or pressure.

Automatic starting equipment for synchronous motors may be arranged conveniently on panels, even for special equipment, as shown in Figs. 2 and 3. The four synchronous motor panels on the left control two 100-hp. 720-r.p.m. 440-volt, and two 125-hp. 514-r.p.m. 440-volt vertical synchronous motors. The center panel is for the incoming line and on the right are two distribution panels to control eight feeder circuits for miscellaneous power and lighting at the Rockford, Ill., sanitary plant.

Push buttons are provided on the panel to transfer the control from manual to automatic operation or the reverse, and also to change the operating sequence of the motors when on automatic control. When on manual control the motors can be started and stopped from push buttons on the panels.

Automatic operation is obtained with float switches that function to start and stop the motors, as the level of the sewage rises and falls, to keep the motors operating at nearly full load. The control is arranged so that





Figs. 2 and 3—Front and rear of control panels for two 100-hp. and two 125-hp. synchronous motors driving sewage pumps. The motors may be started and stopped automatically by the water level operating float switches, or they may be controlled manually with push buttons on the four panels shown on the left, Fig. 2. In Fig. 3 on the right, the main contactors for the motors' control are shown on the rear of the contact board where they may be easily maintained

with four motors 16 possible combinations of operation and sewage level are taken care of automatically.

All the contactors are mounted in the rear of the main board, Fig. 3, with the bus work mounted overhead between the main board and the contactor panels. The contactors and relays are so mounted as to permit convenient inspection. The oil circuit breaker for the incoming line and the auto-transformers are also conveniently located. Both front and back panels, with all equipment, may be handled as a unit.

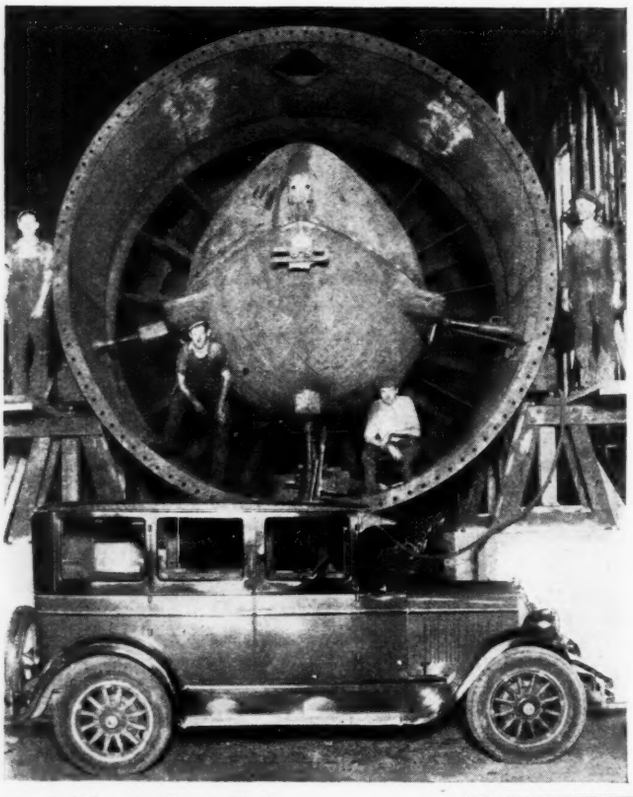


Fig. 4 (Above)—Pump 14-ft. diameter and rated at 1,000 cu.ft. of water per second compared with an automobile

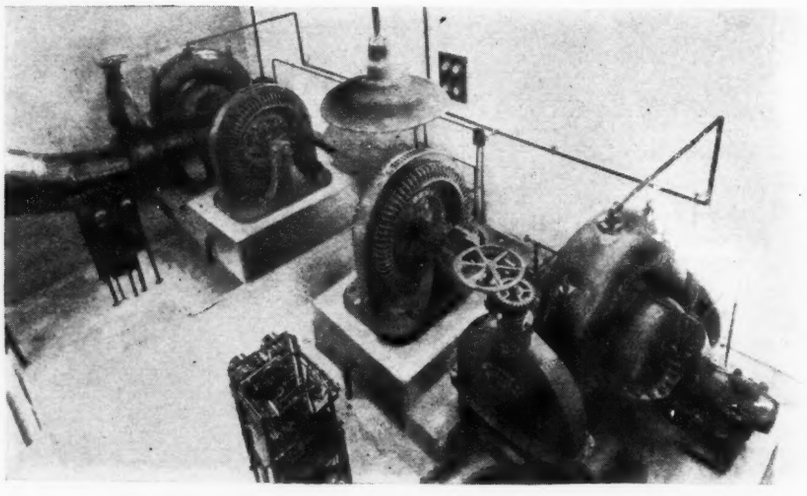


Fig. 5 (Right)—Two 35,000-g.p.m., 22-ft. head pumps driven by 250-hp., 300-r.p.m. synchronous motors

Low-speed synchronous motors may be obtained for direct connection to large volume, slow-speed, low-head pumps, thus eliminating gear units and still obtaining high efficiency and unity power factor. High-speed synchronous motors may be obtained for direct connection to high-speed, high-head pumps.

Synchronous motors are available in both vertical and horizontal types. Vertical motors are normally supplied with thrust bearings capable of carrying the hydraulic thrust and the weight of rotating pump's parts in addition to the weight of the motor's rotor. If necessary, these can be built to withstand the runaway speed of the centrifugal pumps which they drive so that, if power fails and the discharge valve of the pump remains open, the pump will not drive the motor in the reverse direction fast enough to injure it. Brakes can also be supplied to hold the unit stationary in case there is a small leakage in the pump discharge valve.

Standard synchronous motors normally have ample torque for starting and pulling into step when connected to centrifugal pumps. Synchronous motors having torques higher than standard can be obtained for unusual centrifugal-pump applications or for driving reciprocating pumps. Where slow-speed drives are required, the synchronous motor has a considerable price advantage over induction motors, and this advantage increases with the larger horsepower ratings. In the case of a 2,000-hp., 93.8-r.p.m., 25-cycle motor, the price ratio is almost 2 to 1 in favor of the synchronous motor, while for a 400-hp., 1,800-r.p.m. motor, the price ratio is reversed and is about 1.5 to 1 in favor of the induction motor.

There is practically no limit to the maximum size of motors that can be built. The limit is the size of pumps that can be used without causing too large a change in the water flow to the hydraulic system. Synchronous motors smaller than 75 hp. at 1,800 r.p.m. are seldom used, although they can be obtained in smaller sizes if desired. In the following are examples of typical installations of synchronous-motor driven pumps.

The city of New Orleans, La., recently installed nine 2,000-hp., 93.8-r.p.m. and five 1,200-hp., 83.3-r.p.m. synchronous motors for driving low-head pumps, used to pump rain water from the lower portions of the city into Lake Pontchartrain and Lake Borgne. Some idea of the physical sizes of these pumps may be obtained from Fig. 4, comparing one of the pumps with an automobile. These pumps are among the largest if not the largest in the world. The intake and discharge of those driven by the 2,000-hp. motors are 14 ft. in diameter. Each of the large pumps delivers approximately 1,000 cu.ft. of water per second when pumping against a head of 14 ft.

Whether the project may be an irrigation district requiring a large volume of water at a low head or a city requiring a large volume of water to be pumped from a stream or lake into the filter beds, equipment

similar to that in Fig. 5 may be used to advantage. Here 250-hp., 300-r.p.m. synchronous motors are used to drive pumps delivering 35,000 g.p.m. against a 22-ft. head.

The city of Detroit will soon complete one of the largest pumping stations in the world for handling its water supply. Before the plant was laid out a careful study of conditions and methods of pumping the required water was made and the cost of the various sources of power was closely analyzed. It was decided that synchronous-motor drive would be the most efficient and also the most desirable. In the plant which is now under construction, synchronous and induction motors are used to drive pumps to deliver water from a reservoir to the filtration plant. Synchronous and induction motors are also used to pump the filtered water from the storage reservoirs into the high-pressure city main.

Six 750-hp. synchronous and two 350-hp. induction motors are used to drive the low-lift pumps. Four 1,725-hp., 600-r.p.m., two 1,675-hp., 514-r.p.m., and two 1,425-hp., 514-r.p.m. synchronous motors are used to drive the constant-speed high-speed pumps, while two 1,400-hp., 720-r.p.m., and two 1,200-hp., 514-r.p.m. induction motors are used to drive the adjustable-speed pumps. This station shows a well-balanced combination of synchronous and induction motors especially when it is considered that the water is pumped directly into the main.

The synchronous motors take care of the continuous portion of the load, while the wound-rotor, induction motors are used to handle the variations in demand that are too small to permit starting and stopping a synchronous motor.

It is evident that synchronous motors, being a constant speed type, are not so well suited to take care of the fluctuating portion of the load, since it is not economical to throttle a centrifugal pump in order to obtain an appreciable change in output. The usual method of varying the flow is to change the speed of the driving motor. This cannot be done with synchronous motors so wound-rotor induction motors with secondary control are generally used.

If it is desired to change the output of a reciprocating pump, it is necessary to change the speed, and synchronous motors, being constant-speed motors, cannot be used for such drives. Wound-rotor, induction motors with secondary resistance, or brush-shifting type adjustable-speed motors are both suitable for driving reciprocating pumps. The wound-rotor type of motor is available in practically any horsepower capacity desired, while the brush-shifting type adjustable speed alternating-current motors are somewhat restricted in range of sizes.

In cases where it is necessary to limit the starting current of synchronous motors, auto-transformers or reactors may be used to reduce the initial inrush. If the simplest form of starting equipment is desired and the starting current is a minor consideration, full-voltage starting may be used.

In extreme cases where the starting current must be kept low or where high starting torque and low starting currents are required, wound-rotor induction motors can be used to better advantage.

Since the load in the average municipal pumping station has a large constant component with a small variable component, it lends itself unusually well to constant-speed driving units. With operating costs being constantly scrutinized, it is desirable to install equipment that will keep them at a minimum over a long period.

▼ ▼ ▼

Banking Fires On Overfeed Stokers

By H. M. SPRING

A BOILER PLANT supplying steam for industrial service, and consisting of water-tube boilers, hand-fired, recently raised its boilers about 4 ft. and installed overfeed stokers. As rebuilt, the furnaces were about 14 ft. wide, and the side walls were lined with carborundum brick for a distance of 24 in. above the grate line, the rest of the furnace lining being firebrick. The boilers of this plant were normally in operation for about fifteen hours a day. The fires were banked from about 10 p.m. until 7 a.m., there being no operators in attendance then.

With the previous hand-fired furnaces little or no trouble had been experienced in holding a banked fire on the grate all night, nor was difficulty experienced in starting up the next morning, since there was always sufficient fuel bed left on the grate to allow of easy and rapid starting. During the first week or so of operation with the new overfeed stokers, however, considerable difficulty was encountered. A number of different methods of banking were tried, and some resulted in a dead fire in the morning, while others burned up too rapidly during the night, not only burning the fires out, but blowing the safety valves. This was dangerous, due to the loss of water from the boiler, and, in addition, caused complaint from nearby apartment houses. A satisfactory method of banking was finally hit upon which not only carried the fires through the night without the generation of steam in the boiler, but resulted in fires sufficiently live to insure rapid and easy starting up in the morning. The procedure was as follows:

About a half hour before the time when the fires would be banked, and at a time when the load would allow the pressure to be dropped somewhat, the coal pushers were cut out and the agitation of the grates materially reduced. The air flow was also increased, so as to burn the fire practically out before banking. When this burning-out had been completed, the agitation of the grate sections was increased to its maximum, and the ash, clinker and remaining live coals were pushed down and dumped into the ashpit. This refuse was wet down and cleaned out at once. The rocking grate was then left bare. The agitation was stopped, the air shut off, and a hopper-full of fresh coal was fed in on the front section of the grate.

Throughout the preceding operation the carborundum brick along the side walls at the grate line had held sufficient heat to maintain these bricks at a bright red heat. The heat from these side walls was sufficient to ignite the coal next to them, the burning progressing slowly from the sides toward the center. Sufficient bed remained, however, to enable easy and rapid starting in the morning. When the fires were banked over Sunday about twice the amount of coal was fed in, with the same results, the banked fire lasting until Monday morning.

Condenser Research Shows Effect of Tube Arrangement

Results indicate that coefficient of heat transfer in a surface condenser is closely proportional to condenser rating, if water-inlet temperature and condenser water rate are constant. With a given water-inlet temperature vacuum depends, within limits, almost entirely on the condenser water rate.

By F. A. MAX WÜLFINGHOFF

AT THE Berlin Technical University Dr. Jungnitz recently conducted tests on a small model condenser for the purpose of finding answers to the following questions:

Is the assumption correct that, with a given water-inlet temperature, the saturation temperature, and consequently the vacuum, in the condenser depend only on the condenser water rate K/D, where K is circulating water in pounds per hour and D is the pounds of steam condensed per hour, or does the absolute value of these quantities exert an influence?

What is the effect of different cooling surfaces, different tube diameters and tube lengths, of different arrangements of tubes, of bafflings, of special flow principles, on the water side and on the steam side?

What are the variations of the coefficient of heat transfer k with a given rating D/F, where F is the square foot of tube surface in the condenser if the water rate K/D be changed?

The outer dimensions of the model condenser, Fig. 1, used in the tests were taken so as to obtain proportions similar to those of a modern full-sized condenser. Tube diameters, however, were not reduced in proportion, but were 18 mm. x 20 mm. (0.70 in. inside and 0.78 in. in outside diameter) or nearly the same, as used in full size condensers. This circumstance renders comparing the conditions in the smaller condenser against those of full size somewhat difficult.

In the first test series the cooling surface was 4.31 sq.m. (40.4 sq.ft.) and it was formed by 98 copper tubes 700 mm. long (27.3 in.) arranged in horizontal rows, the condenser being of the two-pass type, each pass containing 49 tubes. Thus the water inlet and outlet were in the same end plate. As usual, the inlet orifice was the lower one.

An electrically driven centrifugal pump drained the lower part of the condenser through an outlet in the middle of the length of the condenser shell; the condensate was pumped to a weighing tank. A throttling valve had been arranged in the discharge pipe; the suction pipe contained a water level gage. By suitably regulating this valve, the condensate in the suction line could always be maintained at the correct level, thus permit a uniform flow of condensate to the weighing tank.

As the in-leak of air could not be entirely disposed of,

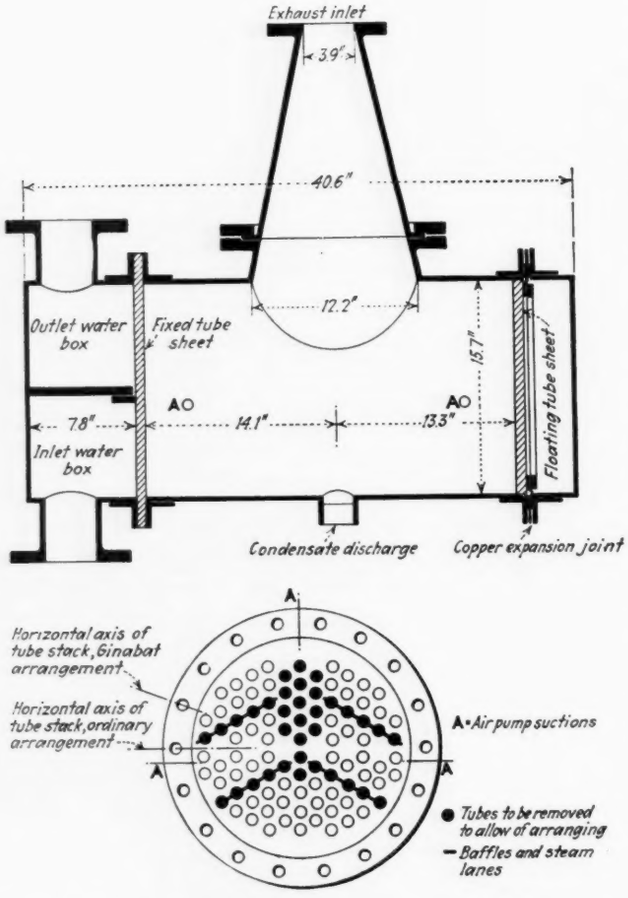


Fig. 1—Model condenser used in tests contained 98 copper tubes of .78 in. outside diameter

steps were taken to ensure at least a certain uniformity in the influence of the air entering mainly with the steam. A water-jet air pump working at constant pressure was connected with a manifold on which connections were provided for six air-suction pipes of ½ in. each. Near each end the condenser was tapped in three places as shown at *A* in Fig. 1.

The steam from the heating steam main available for this test had a pressure of 6 atm. (85.3 lb.) and was slightly superheated. In the steam supply line, at a distance of about 10 ft. from the condenser, a valve was installed in which the steam was throttled down to condenser pressure almost in a single step. This throttling process caused sensible superheat, which was removed by a trickling device that cooled the outer surface of the steam pipe by means of water sprays insuring uniform distribution. Immediately before the condenser inlet a second valve was installed to exclude the possibility of forming a steam flow in which only the outer zone would be cooled, the nucleus remaining superheated, in which case a mixture of superheated steam and water would have been supplied to the condenser. The repeated changes in direction and the eddying caused by the second valve were intended to produce a uniform mixing of these two phases before they reached the condenser.

Steam temperature was measured at the exhaust inlet nozzle of the condenser by a calibrated mercury thermometer. Up to 5 deg. C. (9 deg. F.) of superheat was admitted, as this small amount is negligible compared with the considerable condensing heat of the low-pressure steam; and wet steam entering the condenser would be undesirable because its enthalpy cannot readily be determined on account of the moisture.

Finding the pressure in the condenser proved comparatively difficult. In the lowest part of the steam inlet nozzle a small diameter tube was tightly screwed, which was connected by a short length of substantial rubber hose to a liquid gage consisting of a glass tube with a reservoir at its top, into which mercury was drawn up from a small cistern at the bottom. The length of the column was read by means of a metal scale, the zero point of which could be adjusted exactly flush with the level in the cistern. With this arrangement, the capillary depression was negligible, as it was practically the same in the cistern at the bottom and in the reservoir at the top of the tube. Allowance was made for the temperature changes of the mercury column at the time of observation. The influence of the condensate which is inevitably formed above the mercury and which weighs upon the latter was also considered. The absolute condenser pressure was obtained by simultaneous reading of a barometer, the difference between the corrected liquid gage reading and the latter yielding the absolute condenser pressure.

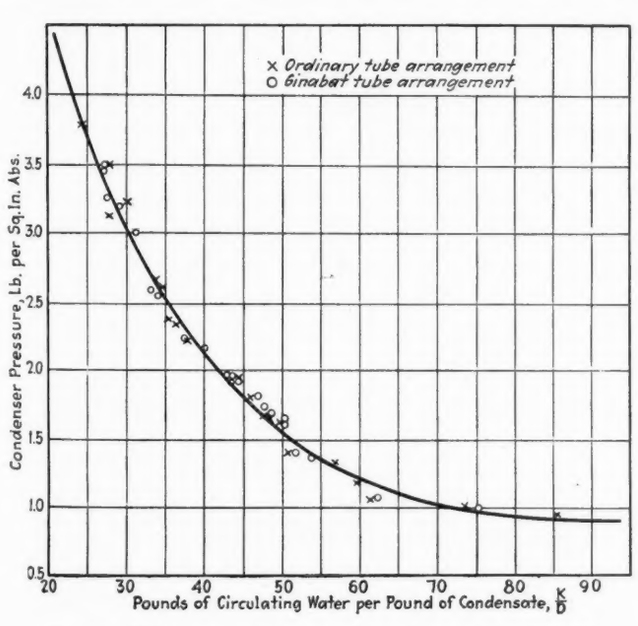


Fig. 2—Effect of condenser water rate on vacuum with different tube arrangements

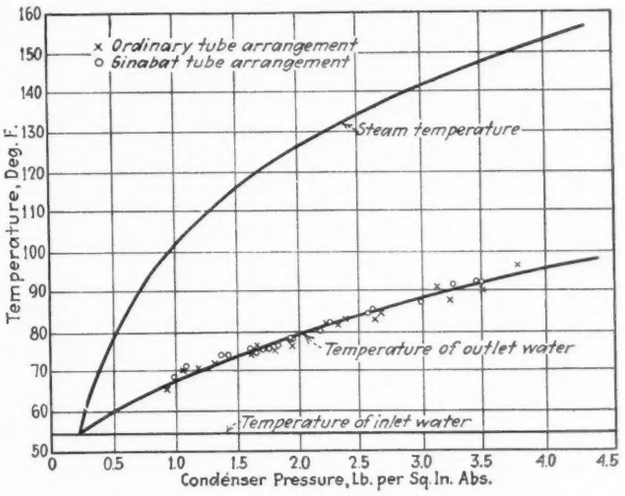


Fig. 3—Circulating water temperatures for ordinary and Ginabat tube arrangements

Of course, there will always be some slight differences in vacuum readings at different parts of the condenser, the maximum vacuum being at the air pump suctions. Hence the vacuum at the exhaust inlet will read low, even when the pressure drop between the steam inlet and the condensate outlet is negligible. But as these tests were mainly comparative the correctness of the results remains unaltered.

Before the second series of experiments was conducted the cooling surface was reduced by removing 35 tubes, leaving 37 tubes in the lower pass and 26 tubes in the upper. The deflection plates shown in Fig. 1 were installed and later on removed to ascertain their influence.

Because both the condensate and the cooling water quantities had been measured, the correctness of the readings of each series of tests could be checked by the condenser heat balances. It was found that the heat absorbed by the circulating water was about 1 to 3 per cent less than that given up by the steam. This is due to heat losses, as the condenser temperature was comparatively high. The conformity of the comparisons indicated that the air pump had not extracted undue quantities of noncondensed steam.

The purpose of the first series of tests made was to find out whether the Ginabat arrangement of condenser tubing would show the favorable performance usually anticipated. With this arrangement the condensate dripping from the lower parts of the upper tubes does not strike the top of the tubes below, but their periphery in a tangential way.

Tubes were spaced in the model condenser about three times the radius of a tube. It will easily be seen that displacing the whole tube nests with their tube plates by an angle of about 20 deg. produces the Ginabat arrangement. To allow of this, 18 holes for the bolts connecting

the condenser shell to the water space were drilled into the tube plates. Thus displacing the tube system by one bolt hole gave the desired effect.

Both the weights of the water and of the steam were varied within wide ranges, the inlet temperature of the water remaining fairly constant; and tests were made with ordinary and with Ginabat tube arrangements. The condenser rating for one series of tests was kept constant as far as possible, the cooling water quantity being varied.

In Fig. 2 the obtained condenser pressure has been plotted against the condenser water rate, without considering the corresponding condenser ratings. This curve shows that the Ginabat arrangement in itself yields no better vacuum than the ordinary tube arrangement. It can be said that Fig. 2 demonstrates that with fairly constant water inlet temperature the vacuum obtained depends almost exclusively on the condenser water rate. This will, to a certain extent, hold true regardless of the absolute value of the numerator and denominator of the ratio constituting the condenser water rate, if the condenser rating does not pass a certain limit. With this condenser arrangement this condition occurs as soon as the rating reached about 210 kg. per square m. per hour (39.1 lb. per sq.ft.).

Fig. 3 shows the circulation-water outlet temperature and the saturation temperature plotted against the condenser pressure. The ordinary tube arrangement gives the same results as the Ginabat. The lowest possible saturation temperature, hence, the highest vacuum, is obtained when $t'' = t_a = t_e$, when t_a is circulating-water outlet temperature and t_e is inlet temperature. With infinite circulating-water quantities, no difference exists between the actual and the perfect condenser, as the saturation temperature and the water outlet and inlet temperatures become identical.

The coefficient of heat transfer k for this particular condenser is plotted in Fig. 4 against the water rate for different ratings, constant water velocity lines having also been drawn.

In Fig. 4 it has been assumed that the temperature of the steam side is the saturation temperature corresponding to the condenser pressure, the latter being actually higher than the pressure of the steam in itself, on account of the air leaking in. These curves show

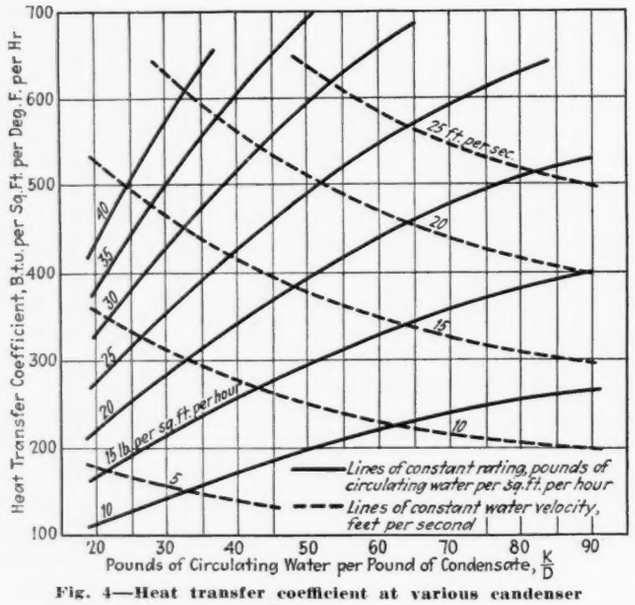


Fig. 4—Heat transfer coefficient at various candenser water rates

that the coefficient of heat transfer connot be plotted against one variable, such as flow velocity, nor can it be found for any given arrangement in general. With different condenser designs results would be too entirely different and no formula will give accurately the k value, though many efforts have been made to find an accurate simple law.

It is often assumed that, with D/F constant, $k = C\sqrt{w}$, where w is the circulating-water velocity.

To check the correctness of this formula the following table has been prepared from Fig. 4. The deviations from a mean constant C value are not appreciable. It is sufficient to check the results for some assumed condenser rating, say 15 lb. per square foot per hour, as, the tendency of all curves being the same, the corresponding results must hold true for all other loads.

Circulating Water Velocity w Ft. per Sec.	Heat Transfer Coefficient k B.t.u. per Sq.Ft. per Deg. per Hr.	$C = \frac{k}{\sqrt{w}}$	Per Cent Variation of C From Mean Value
5	175	78	—2.2
10	275	88	0
15	340	88	0
20	400	89	+1.1

In actual service the circulating-water quantity and velocity will generally remain unchanged. Fig. 4 shows that under this assumption the heat transfer coefficient increases when the rating increases, but not to the same degree. In spite of this the vacuum will be reduced on account of the condenser water rate becoming less with increased rating (see Fig. 2).

Tests With Buiilt-in Baffling

After the condenser had been modified, with the cooling surface reduced to 2.77 sq.m. (29.7 sq.ft.) new tests were made to determine the influence of the baffle plates collecting the condensate on the coefficient of heat transfer. First, the modified condenser was again investigated at different loads and with different water quantities. The four baffle plates collect the condensate dripping from the tubes above and their purpose is to conduct it sideward to the condenser shell along which it flows to the hotwell. This avoids flooding the lower tubes and so improves the mean heat transfer coefficient.

Directly after these tests the baffling was removed and a new series of tests was begun. Care was taken to execute all tests of the same kind as quickly as possible in order to eliminate so far as possible all influences from slow forming of deposits in the inner tube surfaces.

Throughout the tests the circulating-water quantity was kept constant so far as possible, the condenser rating being varied, which proved easier than the method used in the first service of tests. The results have been plotted in Fig. 5 against the absolute condenser pressures obtained. The curves show clearly that the baffling has a favorable influence on the performance obtained. The temperature differences between the saturation temperatures corresponding to the condenser pressure, and the water outlet temperatures become less if baffles are installed, and hence the vacuum obtained with a given water rate becomes better. Fig. 5 also shows the water rate necessary for obtaining a given condenser pressure which has similarly been plotted against this pressure. It is seen that to reach a given vacuum the water rate is less when baffling is built in. However, the influence of such baffling becomes smaller with increasing water rates. Thus where there is available an unlimited quantity of circulating water the handling cost of which is not prohibitive, the vacuum attainable in a given condenser will be obtained without special devices for removing the con-

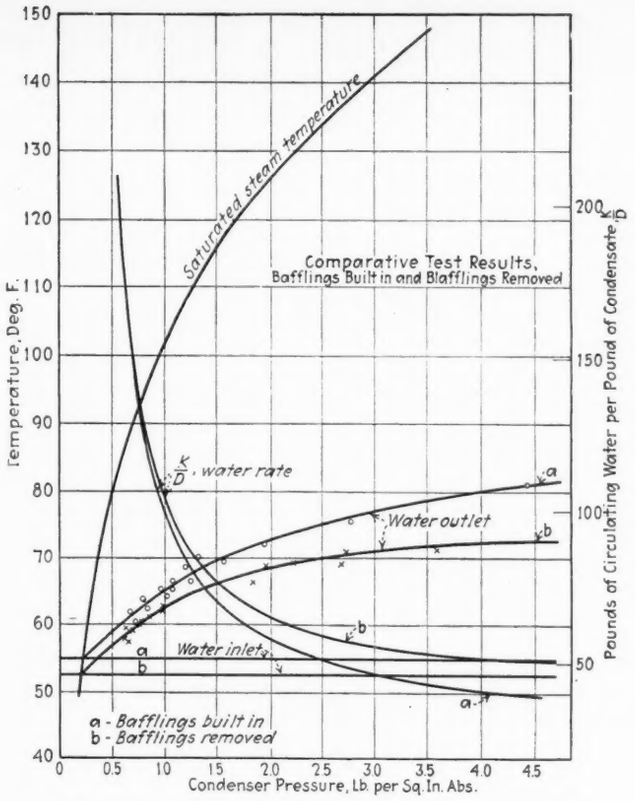

Temperature, Deg. F.
Pounds of Circulating Water per Pound of Condensate
Condenser Pressure, Lb. per Sq. In. Abs.
Saturated steam temperature
Comparative Test Results,
Bafflings Built in and Blafflings Removed
K/D, water rate
Water outlet
Water inlet
a - Bafflings built in
b - Bafflings removed

Fig. 5—Comparative condenser performance with and without baffling

densate dripping down from the tubes. On the oher hand, installing baffles is more conducive to a good vacuum the smaller the economical water rate.

In general, the heat transfer coefficient of a surface condenser is almost proportional to the condenser rating, if the water-inlet temperature and the condenser water rate are constant. This statement holds true for a load range within 35 and 210 kg. per square meter (7.2 and 43 lb. per square foot) per hour. The relation is explained by the fact that the heat transfer rates from steam to tube wall and from tube wall to water increase in approximately linear proportion with the rating, at constant water rate.

The vacumu depends, within the given limits, almost exclusively on the condenser wate rrate rather than on the absolute values of the water quantity and of the steam quantity, if the influence of the variations in the amount of air leaking are neglected or if the air pump can be adjusted to match the load requirements.

If at constant rating and water-inlet temperature the water quantity is altered, the heat transfer coefficient varies approximately with the square root of the water velocity, hence, for a given condenser, with the square root of the water quantity.

If for a given load and a given water quantity the heat transfer coefficient of a condenser is known, that for any other service condition can be computed by using these two laws, and the corresponding fluctuations in vacuum can be predetermined approximately.

Further, the heat transfer coefficient for unit load E can be adopted as a condenser characteristic, that is, the measured heat transfer coefficient divided by the corresponding rating. This figure yields a far better standard for evaluating the performance of surface condensers than does the heat transfer coefficient k, as the latter is too much affected by the condenser rating, that is, by the size of the cooling surface. Condensers showing a good vacuum yield conspicuously low heat transfer coefficients if the cooling surface is a little too ample. This misleading effect is eliminated by determining the corresponding E value.

The vacuum is not decreased by increasing the condenser rating if the water quantity increases simultaneously. Hence if the circulating water is easy to obtain, amply dimensioning the cooling surfaces is futile, because it would only tend to produce undercooled condensate. Under certain circumstances it may be possible to obtain a better vacuum by reducing the surface.

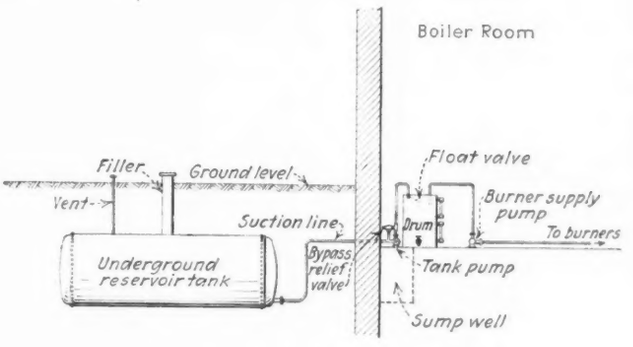
Further measures to improve the vacuum would be, apart from a correct design and suitable means for air removal, those tending to reduce the condensate film thickness on the tubing. However, this cannot be done by simply arranging the tubes in such a way as to make the condensate drip from a top row tube and hit the tube below tangentially. A recommendable practice is to install baffling which catches the condensate and prevents flooding of the lower tubes. The effect of such baffling is greater the smaller the condenser water rate that the technical and economic conditions allow.

Reducing Moisture in Fuel Oil

CONSIDERABLE DIFFICULTY is experienced in certain localities from too high a moisture content in fuel oil. This shows up in the furnace usually by poor atomization, with the flame tip apparently disintegrating into showers of brilliant white sparks. The increased cost of oil with lower moisture content may be avoided in many small installations by providing a simple form of separator, as illustrated.

A steel drum is installed with a low-head pump drawing oil from the outside reservoir and discharging into the drum through a float-operated valve. The float valve connected at the top of the drum controls the outflow from the discharge of this pump, and keeps a constant level in the tank regardless of the demand of the burners. If a gear pump is used a bypass relief valve is also used. The regular burner pump draws oil out of this drum, with its suction about 12 in. below the surface. A drain cock is tapped out near the bottom to sump or waste water.

Although this will not collect all of the moisture in the oil, any trouble from this source will be greatly lessened. The temperature of the oil should be over 100 deg. F., and water should be drained out as it rises. The pump supplying the drum has slightly greater capacity than the one supplying the burners.



Arrangement of oil-handling system

Through a simple system of charting the records of steam and electric meters the W. & J. Sloane Manufacturing Company knows the actual cost of the steam and electrical energy consumed by each of the process departments in its Trenton, N. J., linoleum factory. By comparison of costs of any day with costs of the same day in the previous year the engineering department may be said to conduct a continuous test.

W. & J. Sloane Know Their Power Costs

WHEN the W. & J. Sloane Manufacturing Company embarked upon the manufacture of linoleum at Trenton, N. J., the decision was to purchase electric power and generate the process and heating steam in a modern boiler plant. Three 5,080-sq.ft. cross-drum boilers were installed, and are run at 168 lb. working pressure. Anthracite fines are burned on traveling grate stokers.

Before the factory went into production, the chief engineer decided that economy would not be possible unless records were made of steam and electricity used by each department. High boiler-room efficiency would be unobtainable if the operating force did not have visible indications of the coal burned, the steam generated, the draft pressure, flue-gas temperature and the various other important factors in boiler operation.

To obtain these records the necessary instruments were installed, and a daily log sheet evolved, giving the data listed in Table I, obtained from hourly readings.

From these daily log sheets is compiled a weekly summary, Fig. 2, which includes other items of labor, supplies and maintenance costs, information on which are supplied by the office.

Steam Lines and Electric Circuits

Each of the departments has recording instruments to permit the allocation of the costs of services. Upon the basis of the boiler room log, the substation meter readings, and the weekly report, a monthly report, Fig. 3, is compiled. This shows the amount and cost of the steam consumed and the electrical energy used by each department and its cost. The types of instruments are listed in Table II.

The important items of steam output coal consump-

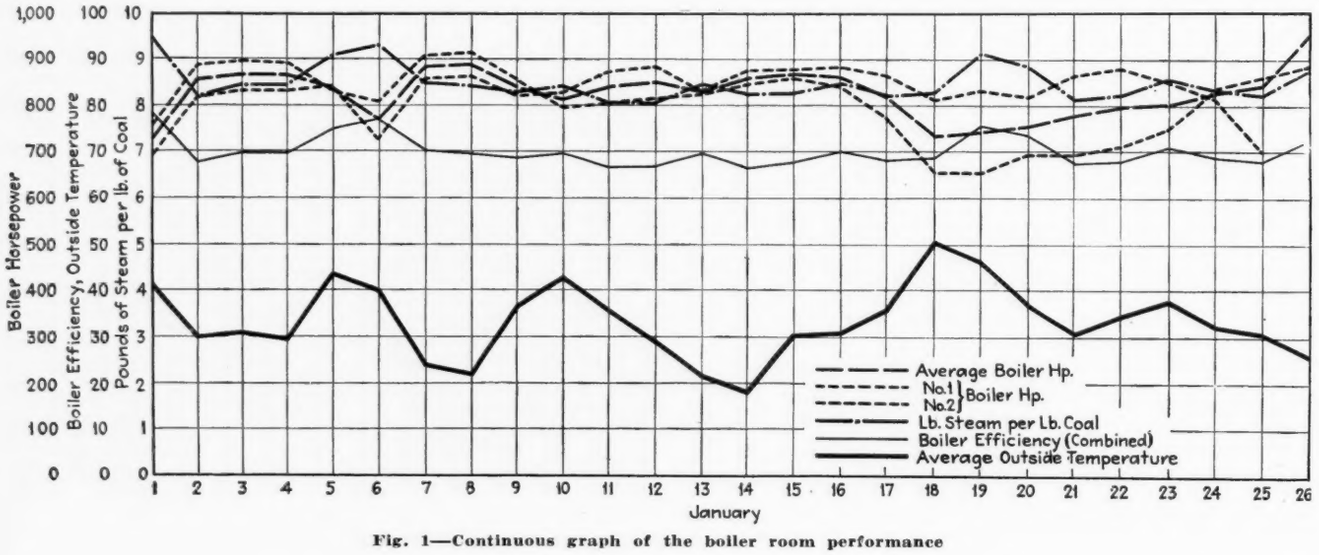


Fig. 1—Continuous graph of the boiler room performance

Form S 45

Weekly Boiler Room Log Summary and Weekly Steam Cost Week Ending ..... 19 .....

Date or Day	Average Outside Temp.	Average Thickness of Fire	Total Lbs. Steam Per Day	Total Lbs. Coal Per Day	Total Lbs. Steam Generated per Lb. Coal	Total Coal Cost	Total Labor Cost	Maintenance Cost	Cost of Supplies	Cost of 1000 Lbs. Steam	Combined Efficiency, (E) in % $E=\frac{F \times w \times 970.4 \times 100}{W \times B.t.u.}$
Total											

Fig. 2—Weekly log for the boiler room

S 79

Month ..... , 193 .... to Month ..... , 193 ....

MONTHLY REPORT

COST OF STEAM AND ELECTRICAL CURRENT TO FOLLOWING DEPARTMENTS

POUNDS STEAM GENERATED, ,COST PER M, LB.

K. W. HRS. GENERATED , COST PER K. W. HR.

DEPARTMENT	Thousand Lbs. of Steam	Cost for Steam	Kilowatt Hours Used	Cost at Elec. Current
Oil Boiling				
Oxydizing				
Cement Mill				
Boiler House				
Cork Mill				
Cork Storage				
Festoons				
P & P Racks				
Inlaid Racks				
Press Room				
Inlaid Mixing				
Lino. Mixing				
Inlaid Trimming				
Shooks				
Warehouse Finish				
Warehouse Raw Storage				
P. & P. Inspection				
Printing Department				
Block Cutting				
Paint Mixing				
Office Building				
Fire & Service Pumps				
Sewage Pumping				
Miscellaneous				
Case Shop				
Roof Sign				
Tank Lights				
Board Signs				
TOTAL				

Form S-40

DAILY TIME REPORT

Clock No. ..... Rate ..... Date .....

WORK PERFORMED	HRS.	AMT.

Signed ..... Foreman

Fig. 3 (Below) — Monthly cost report and Fig. 4 (Inset)—Form used for maintenance work

TABLE I—HOURLY READINGS OF INSTRUMENTS

1—Pounds of coal burned
2—Pounds of water evaporated
3—Feed water heater pressure
4—Feed water temperature
5—Steaming rate, per cent of boiler rating
6—Steam pressure
7—Exhaust pressure, from blower turbines
8—CO_2, per cent
9—Flue gas temperature
10—Draft in furnace
11—Draft differential
12—When safety valve opens up
13—Outside air temperature
14—Pounds of ashes

The pounds of coal burned are noted both as "total" and as "total for steam generation," the difference being the fuel needed for banking.

tion, boiler efficiency are graphed day for day upon a continuous chart as shown in Fig. 1. Record is also kept of the electrical consumption. This permits the engineering department to ascertain abnormal steam and electrical consumption, which is corrected by calling the department heads attention to the excess.

This graph has been plotted continuously since the factory started operation. It is possible then to compare the conditions on any day with those existing on the same date of the preceding year. When this is correlated with the output of the several factory departments, excessive use of steam may be checked. Knowing that the electrical and steam consumptions are being watched, the various departments are less prone to have high peak demands, with the result that the actual energy consumed closely approximates the 15-min. peak registered by the demand meter.

The engineering department has charge of all the repairs on the production machinery and it is charged with all delays occasioned by machine trouble. As a check on the work and to avoid being erroneously charged with factory delay, each workman assigned to a repair job makes use of the Daily Time Report, shown in Fig. 4.

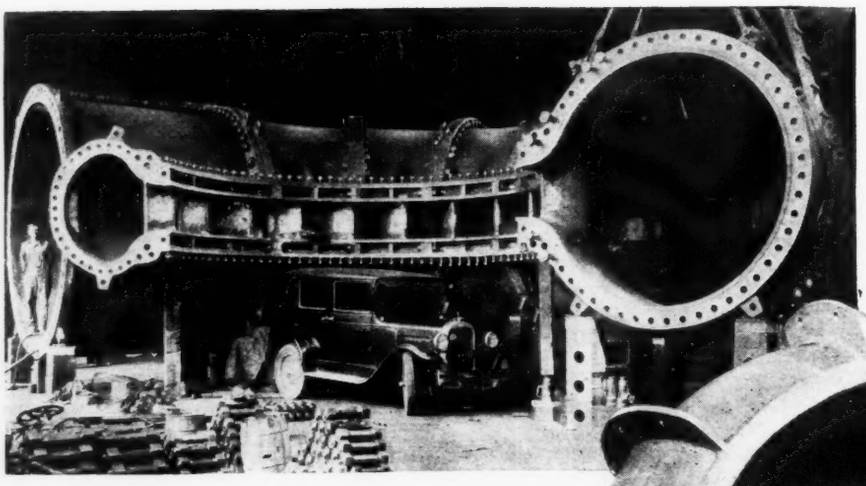
Considering the character of the coal burned, barley anthracite of 12,500 B.t.u. content, 14 per cent ash, 76 per cent carbon, and 0.7 per cent sulphur, the overall boiler efficiency, from 70.6 to 76.7 per cent, is exceptionally good.

The psychological influence upon the boiler room crew of the instruments and the study made of these records each day by the chief engineer is reflected in the results obtained. Despite the rapid fluctuation in steam flow the pressure is practically uniform through the day.

TABLE II—INSTRUMENTS IN THE W. J. SLOANE MANUFACTURING COMPANY'S PLANT

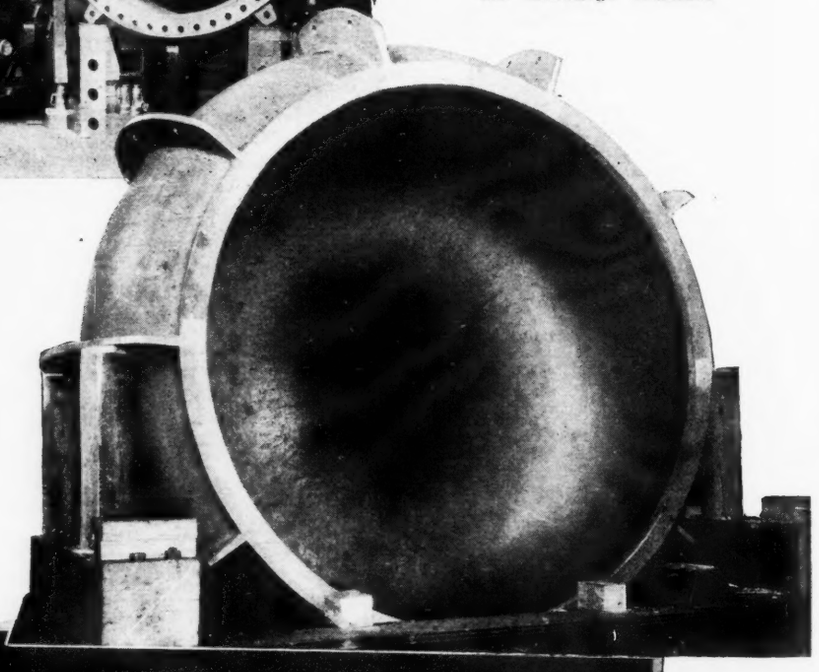
Steam flow meters on boilers.
Steam flow meters in departments.
Feed water V-notch meter (capacity 200,000 lb. per hr.)
CO_2 recorder.
Flue-gas temperature recorder.
Watt-hour meters.
Demand meter.
Voltmeter, ammeter, power factor meters and phase indicators.
Feed water regulators.
Combustion control.
Steam pressure gages.
Water meters on boilers.

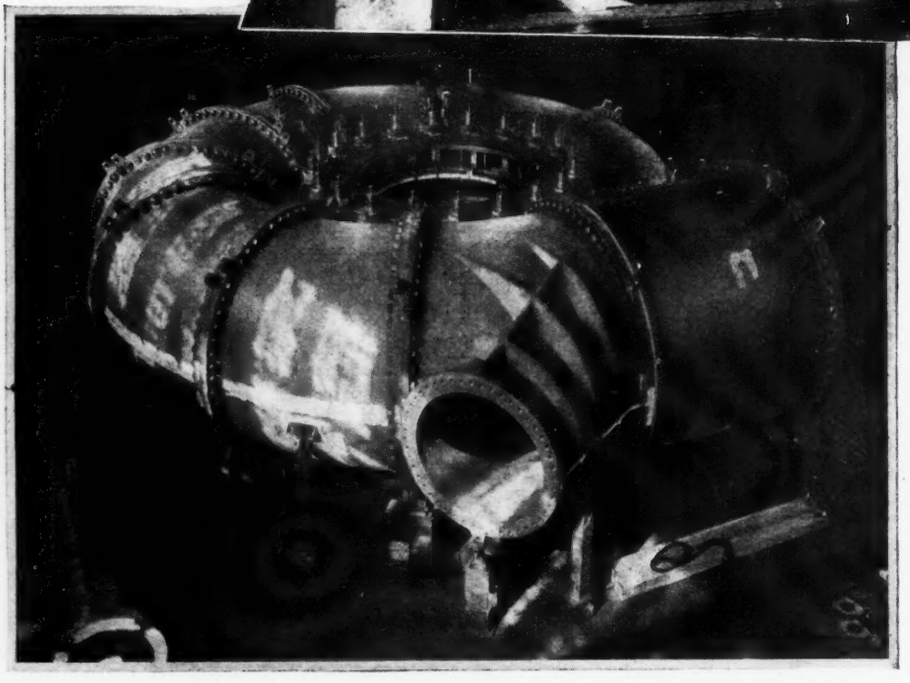
HIGHEST-POWERED TURBINES FOR DIABLO PROJECT



Above—Section of the cast-steel scroll case for one of two 90,700-hp. S. Morgan Smith turbines being installed in the Diablo plant of the City of Seattle, Wash. These are the highest-powered hydro-electric units that have been constructed

Below—One of the jet dispersers for the relief valves. The jet from the relief valve on the turbine casing discharges downward into the receptacle and is turned back on itself. The opposing currents destroy the energy of the stream before it leaves the discharge chamber





One of the cast-steel scroll cases for the two Diablo turbines. These cases are 11 ft. 6 in. in diameter at the entrance and the head is 327 ft. There are also two 2,300-hp. service units that will operate at 720 r.p.m.

READERS' COMMENTS

Setting of Superheater Safety Valves

WITH REGARD to the discussion on the proper setting of superheater safety valves in the Aug. 4 number, I both agree and disagree with M. P. Jared, the author. His statement that all the pressure drop through the superheater need not be allowed for in order to have the superheater valve blow first is correct. If for any reason the steam flow through the superheater is suddenly stopped the superheater pressure will instantly come up to drum pressure; so if the superheater valve is set at any pressure lower than the valves on the drum it will blow first, which is as it should be. But just how much lower the superheater valve should be set depends all on how much pressure drop there is through the superheater, which, as Mr. Jared states, will vary considerably with different type superheaters and with the boiler rating and pressure.

With a boiler operating at 200 lb. and 200 per cent rating the pressure drop through the superheater should not be more than 7 or 8 lb. Therefore, operating close to the valve setting, which is the general rule in low pressure plants, the superheater valve should be set at 204 lb., the first valve on the drum at 208 and the next at 210 pounds.

On a boiler operating at 1,350 lb. pressure and extremely high rating and with a pressure drop of from 30 to 50 lb. through the superheater, about half the superheater pressure loss should be allowed for as with the low-pressure boiler, which in this case would be about 20 lb. Since the superheater pressure loss builds up faster with higher rating it will also fall off faster, so it would not be necessary to lose half the load to cause the superheater valve to blow first. The superheater valve set at 1,380 lb. and the first valve on the drum set at 1,400 lb. should be correct.

I do not agree with Mr. Jared that one of the valves on the drum should be set 3 to 5 lb. lower than the superheater valve, as superheaters are designed to carry all the steam generated in the boiler and heat it to a given temperature. If part of the saturated steam is blown off through one of the drum safety valves it will naturally cause a rise in the superheated-steam temperature and possibly overheating if this condition exists for any length of time. For the superheated-steam loss it is just as desirable to get rid of some excess heat and hold an even temperature on the superheater as it is to get rid of excess pressure. If the superheater valve is open and the steam flow comes back to normal the pressure drop through the superheater caused by the load and the valve blowing together will be enough to make the valve close instantly, whereas if a valve on the drum were open it would blow longer, and more pounds of steam and possibly more heat units would be lost.

With slag-tap furnaces as well as with stoker-fired boilers radiant heat from the fuel bed or slag bed, as the case may be, generally will cause two or more valves to blow if the entire steam flow is suddenly stopped, but if the superheater valve opens first the drum valves will blow for only a short period, after which the superheater valve will take care of all excess steam until normal steam flow is resumed.

Neither do I agree that the pressure rise on a boiler operating at 600 lb. would be as fast from 590 to 600 lb., when the boiler is being brought up to working pressure, as from 600 to 610 lb., when the steam flow is suddenly stopped while the boiler is operating at full load. True enough just as many heat units are required, but it is not good practice to bring a boiler up to working pressure with a furnace temperature equal to full-load conditions; temperature stress on the boiler heating surface would be greater than when operating at full load.

Modern high-pressure boilers with water walls and forged drums should be brought up to working pressure slowly, and with regard to temperature rather than pressure. If three hours are used to bring a boiler up to 600 lb., less than one hour more is all that is required to bring up a 1,350 lb. boiler. When high-pressure boilers are brought up to working pressure with a little regard to the temperature stress on the boiler and with the drain valve on the hot side of superheater open, superheater temperatures will not be above normal.

Regarding the destructive power of superheated steam to safety valves, it is about 90 per cent imagination and does not exist. There is very little difference in the temperature of the safety valve whether steam is blowing through it or not. Tests have proved and I have found from experience that superheated steam does not cut as much as saturated steam. R. SEPTOR.

South Amboy, N. J.

Pulverized Coal Under the Microscope

THIS IS IN REPLY to Mr. E. H. Tenney's letter, published in the Sept. 15 issue of *Power,* commenting on my article entitled "How Pulverized Coal Burns as Shown by the Microscope."

The work of Sinnatt, Newhall, Carlile and others in Great Britain was carried out in the laboratory at much lower temperatures than found in the actual practice of burning pulverized coal. The cenospheres examined by these investigators were what might be called synthetic.

In our studies, reported in *Power,* many specimens of the actual emission from pulverized coal furnaces were examined and a striking confirmation with the work of the above-mentioned gentlemen was found, with some differences. The cenosphere structure was very definite with a variation in the "lattice," depending upon the characteristics of the original coal. At the high temperatures prevalent in pulverized coal furnaces the cenospheres apparently lose their "windows" and leave only the "lattice," or "ribs" to use Mr. Sinnatt's own terminology. With our high-volatile coals much higher magnification was required, but when so enlarged disclosed globular bodies.

The point raised regarding "unaccounted for losses" seems to have been missed. If the value is determined for the loss due to carbon carried away by the products of combustion, it is of course not an "unaccounted for loss." Nevertheless, it is an extra loss which in most tests of pulverized coal equipment is not measured and must necessarily fall into the unaccounted for items. Its presence is noted by an inflation in the value of the unaccounted for loss.

DOUGLAS HENDERSON, *vice-president,*
Fuel Engineering Company of New York.

Tube Failures in 1,400-Lb. Boilers*

IN A REPORT presented at the annual meeting of the German Association of Boiler Owners on April 22, 1931, Dr. Marguerre gives interesting information concerning the difficulties encountered in the operation of the 100 atm. (1,442 lb. per square inch) pressure boilers at Mannheim. These difficulties were principally due to the corrosion of and the burning out of boiler tubes and were found to be caused both by scale formation and by faulty circulation. While the detailed causes of tube failure have not been explained in an entirely satisfactory manner, it seems fairly evident that there is no fundamental connection between corrosion and the operation of boilers at these high pressures.

First Failure After 1,000 Hr.

The first failure occurred after the boiler had been in service about 1,000 hr. On examination it was found that a tube in the combustion chamber had ripped open, and that two other tubes in the same locality showed pronounced bulges. The fact that these three defects were together suggested local overheating, although the appearance of the tube metal did not bear out this assumption. The bulges were found to be completely filled with a mass of loose scale, which consisted, essentially, of iron oxides and sodium sulphate. There was also a thin scale on the outside of these tubes.

Prior to this failure the feed had been almost entirely condensate, although one of the turbines had a leaking condenser. The boiler-feed water had been chemically treated according to the standard treatment recommended for operation at this pressure, and in addition sodium sulphite had been added. After replacing the damaged tube, and running a cleaner through the boiler tubes to remove scale, the boiler was again put in service. The soda alkalinity of the boiler water was maintained at this time at 200 parts per million, and the water was further treated with sodium phosphate to prevent scale formation.

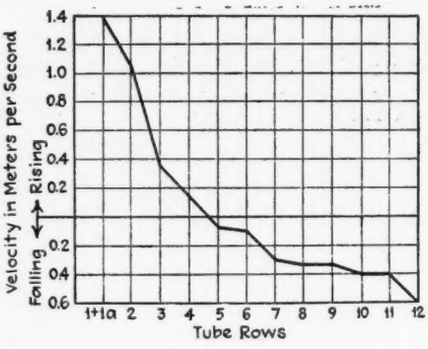
Eight More Tubes Fail

After 48 hr. of operation eight more tubes in the front bank of the boiler were found damaged. As before, all the defects were in one general spot and the bulges were found to be filled with loose oxide scale. At this time it was definitely established that these oxides were not produced at the points where they were found, but rather that they had been carried there and deposited by the boiler circulation.

The logical explanation for the increase in tube failures which commenced shortly after the addition of phosphate was that the scale, loosened by the action of the phosphate, had settled in the tubes at these points and caused overheating. Evidently the scale and sediment had not been entirely removed on the previous shutdown.

Several more experimental runs were made on this and other boilers with and without phosphate, and the general conclusion seems to be that unless the boiler and drums are thoroughly scaled and cleaned throughout the use of phosphate is likely to cause trouble, due to the loosening of fine scale and sediment and the depositing of such loose scale at points in the tubes exposed to high temperature where it will be likely to cause local overheating.

After about 4,000 hr. of operation,



Water velocity at tube inlets in Mannheim boiler at full load

and after a partial clearing up of the difficulties encountered with overheating, due to scale deposits and corrosion by pitting, tube failures of a different type began to appear. In these failures there was no indication of the former bulging, nor of pitting. The metal of the tubes had simply been carried away, forming a groove and leaving a metal thickness of less than 1 mm. Failures of this type began to occur not only in the front banks of the boiler tubes, but also back in the fourth, fifth and sixth rows, the defects always being on the furnace side of the inclined portion of the tubes.

Water Circulation Studied

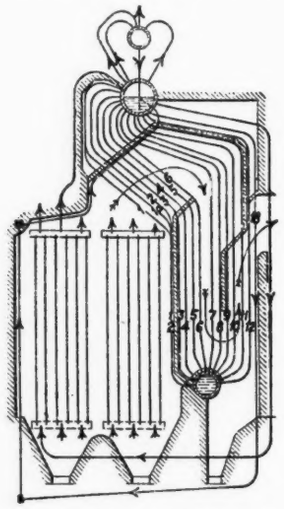
A study was made of the direction of water circulation, and the velocity in the various tube rows. From the result of this study it was concluded that the tube failures of the second type, especially those occurring in the rear tubes of the front boiler section, were due to faulty circulation.

Care was taken throughout the experiments to reduce the oxygen content of the boiler water as low as possible. The failures resulting from corrosion and the depositing of large quantities of loose scale virtually disappeared within a short time after the oxygen content in the feed water was reduced to 0.1 mg. per liter, although at about the same time the failures of the second type commenced. During the later experiments the total alkalinity was dropped to about 100 parts per million, and at the same time the proportion of sodium sulphite was increased. It is not felt that this lower alkalinity reduces the tendency to corrosion, the reduction being made principally to reduce priming.

Although all the detailed causes for corrosion were not entirely explained, it was felt that the matter of water circulation and of temperature distribution was of such importance that it should be cleared up beyond doubt. To insure definitely a positive circulation into and down through certain tubes of the front bank of the boiler the entrances of these tubes within the drum were connected by pipes to the feed box in the drum so as to insure the feed water flowing downward through these tubes. These alterations, together with others made on other types of boilers in the plant, have shown that it is possible to obtain satisfactory circulation at the highest pressures with two-drum boilers, and this without unduly expensive changes in the boiler circulatory system.

Use of Sodium Sulphite

Because of the continuous use of sodium sulphite, the oxygen content in the feed to these boilers is now less than 0.01 mg. per liter. The experiments at this plant have left the operators still uncertain concerning the use of phosphate. After altering the boiler circulatory system, the procedure governing boiler preparation was changed somewhat so as to clean the boiler completely of scale and treat it with caustic before putting it into service. This procedure is now used, and in addition phosphate is added. Entire freedom from scale, however, has not been the result to date. Scale is occasionally formed due to condenser leakage, and it is felt



Directions of circulation in Mannheim boiler

that this scale formation deserves further investigation.

It is Dr. Marguerre's opinion that the operation of high-pressure boilers is not only entirely feasible, but that it no longer offers serious difficulty. The corrosion troubles encountered were not essentially different from those occurring in plants operating on 200, 400 or

*Abstract from London *Engineering*, Aug. 28, 1931.

600 lb. pressure, and therefore could not be charged to the high pressure. He states that their task would have been considerably simplified but for the continually recurring idea that they were dealing with something essentially connected with a pressure of 100 atmospheres.

X-Ray Analysis Now Part of Electrical Manufacturing

HIDDEN DEFECTS in castings, welds and electric machinery, hitherto difficult or impossible to detect visually or by ordinary methods, are now revealed by the spotlight of the X-ray in the largest laboratory of its kind in industry, recently added to the manufacturing facilities of the General Electric plant in Schenectady. This laboratory is completely equipped with a substation, rooms for taking X-ray pictures, photographic darkroom and air conditioning plant.

A 200,000-volt X-ray tube is used, the highest voltage rating commercially available, the equipment being the standard hospital deep therapy type built and installed by the General Electric X-ray Corporation. Products varying in size from very small devices to castings weighing many tons can be photographed. Two rooms are provided for this purpose, one about 11 ft. square by 9 ft. in height for the small equipment, and the other 24 by 26 by 17 ft. high, approximate dimensions, for large castings and machines.

In operation the piece to be photographed is set in place, the film put in position and the X-ray tube placed at the proper point by means of an overhead suspension system in the large room and a standard hospital therapy mounting in the small room. Because of the high-voltage X-rays employed, both rooms are very carefully shielded with lead lining on the roof and walls, lead sheets $\frac{1}{4}$ and $\frac{1}{8}$ in. thick being used and held in place by lead-headed pins. This lead lining extends into the ground about 4 in. While the X-ray photograph is being made the operator can watch the equipment through a suitably located window of lead glass.

One of the accessories in the laboratory which has been found particularly valuable is a stereoscopic viewing equipment. By taking two X-ray photographs from slightly different positions in a manner analogous to the operation of a pair of human eyes, and then placing the negatives in this equipment, an effect of depth is created. Thus the analyst can look into the casting or device and see structural details in their proper relative positions.

Recent uses of the laboratory include the examination of cast tool steel as part of the raw material inspection, inspection of a mercury-arc rectifier assembly of rolled plate stock, study of a ball bearing assembly for a motor, the comparative tests of welds made by different processes, and other weld inspections.

Ironbridge Power House an Example of Modern British Construction

This quaint old bridge over the River Severn gives the modern power plant (not shown) its name

A STEAM-ELECTRIC power station with an initial capacity of 50,000 kw. and an ultimate of 200,000 will shortly be opened in Great Britain, according to an article in *The Electrical Times* (London). Ironbridge is the name, the plant being close to a historic iron bridge on the River Severn. The station was constructed by the West Midlands Joint Electricity Authority.

The plant was originally projected to contain five 25,000-kw. sets, but the whole plan was later revised for an ultimate capacity of 200,000 kw., comprising four 50,000-kw. machines. The present section consists of the necessary building for two 50,000-kw. machines, with boilers and other essentials, but only one machine is being installed at the present time.

ULTIMATE COST PER KILOWATT WILL BE $64

These details, and those that follow, are based on the article in the *Electrical Times*. It is there stated that the cost per kilowatt of this plant, for the first 50,000 kw., will work out $92, reducing to about $68 for 100,000 kw., and $64 for the completed station of 200,000 kilowatt.

House-service sets are omitted, emergency current being obtainable from outside sources.

All auxiliaries are equipped with alternating-current constant-speed motors. The only steam-driven auxiliary in the plant is the stand-by feed pump. In a few cases where variable speed is desirable it is provided by a special variable-speed hydraulic coupling containing oil. This can be remotely controlled by electrical means, and give any change of speed that may be required. Similar couplings are used at Lister Drive and Clarence Dock stations.

The coupling is of a pump-turbine type, with an impeller and a runner. Alterations in speed are dependent on the slip.

The employment of these couplings has permitted the use of squirrel cage motors started directly from the main, even for the 150-hp. induced-draft-fan motor, and has thus eliminated starting gear.

STEAM AT 400 LB. AND 800 DEG.

The steam conditions in Ironbridge station are 400 lb. per square inch pressure and 800 deg. F. steam temperature at the boiler.

Three Stirling-type boilers have 21,600 sq.ft. of heating surface each in addition to a front screen with 7,750 sq.ft. of surface.

The maximum evaporative capacity per boiler is 270,000 lb. per hour and the normal 225,000 lb. Each boiler has one economizer and two air heaters of the regenerative type, giving a final flue temperature at the outlet of the air heater of 260 deg. F.

Pulverized fuel is used, each boiler being equipped with three seven-ton mills, twelve cyclone separators, two forced- and two induced-draft fans.

Four-stage heating has been adopted. Make-up is produced by two bled steam evaporators. A water-jet system of ash disposal is used.

In designing the buildings it was necessary to consider the fact that the river is subject to a 24-ft. flood rise.

FROM AMONG READERS' PROBLEMS

Conducted by

L. H. MORRISON

EFFICIENCY OF YELLOW OIL FLAME—*We are studying the plan of placing oil burners in our heating boilers. One burner salesman claims that his burner gives a yellow radiant heat flame, which, he says, is more efficient than a blue flame. Is there anything to this?* P.M.

Tests have proved that oil burners giving a yellow flame are as efficient, but no more so, than a blue-flame burner. A blue flame indicates that the fuel has been vaporized below its ignition temperature, combustion being from a gaseous state. The yellow flame indicates that there are incandescent particles and combustion proceeds through the combination of air with the exterior molecules of these particles. The difference in the flame produced by a burner depends upon the method of fuel introduction into the furnace.

PREVIOUS QUESTION DISCUSSED BY READERS

THE QUESTION

THE CONDENSATE from our heating system returns to a receiver tank from which it is removed by a vacuum pump and delivered to an open feed-water heater. The pump operation is controlled by a float valve in the receiver. We find that with this arrangement the pump operation is very irregular. When it stops exhaust steam is wasted to the atmosphere and when running the feed-water temperature is low. What can we do to secure more steady operation? L.M.D.

WHEN it is stated that the pump operation is controlled by a float valve, it is assumed that the float valve controls the speed of the prime mover. If it is connected so as to control the flow to the pump suction the trouble is apparent.

If the float is connected correctly and works freely without sticking, the radiator traps should be examined to see if they are blowing through, resulting possibly in too high a receiver temperature for the available suction head. If the vacuum pump is a steam driven reciprocating unit, as is very common, the throttle valve controlled by the float may be sticking due to tight or old spindle packing. This will result in extreme condensate levels in the receiver, with the pump either running at higher than normal speed or stopped for several minutes before the float gets enough excess force from the incorrect water level to operate. This trouble may be detected by the pump regulator moving suddenly from one extreme to the other when it operates instead of finding an average position and holding it. Providing the pump and receiver have given this difficulty since they were first installed it may be that the regulator is too large, giving a coarse speed adjustment. The pump may be to large for the capacity of the heating system. In the latter case a partial throttling of the pump discharge will help. The receiver should be placed in such a position that the water level varies sufficiently in relation to volume that the float will have a fair travel from high to low water levels.

As to the exhaust steam being wasted it is very likely that this will be negligible when the contributing factors are corrected H. M. SPRING.
Milford, N. J.

AS THE SIZE of the receiver, the amount of condensate and the quantity of feed-water required are not stated, it is impossible to give a definite solution of the problem. However, from the information provided, it appears that the vacuum pump delivers the water to the heater at a greater rate than the flow of steam for heating the water, hence the low temperature. Whatever the solution, the chief aim should be to obtain more nearly constant flow of water to the heater. Assuming that the steam supply to the heater and the boiler feed from the heater are constant, there are two solutions to the problem.

Solution 1. Arrange the float in the heater to control the operation of the vacuum pump and have the float in the receiver lowered and adjusted to operate the regulating valve on a make-up line to the receiver. With this arrangement the vacuum pump will discharge at the rate that the water is drawn from the heater. Should the returns not be sufficient to supply the boilers, the make-up valve would open admitting water to the receiver.

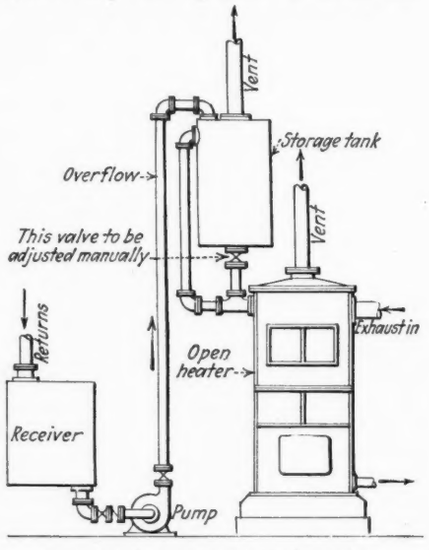
Solution 2. Place a surge tank above the heater and discharge the vacuum pump to this tank. Have the make-up piped to this tank and controlled by a low-level float in the tank. The float in the heater should control the regulating valve on the water line between the surge tank and the heater. This arrangement would permit more nearly constant feed to the heater.

A. L. JONES.
Harrison, N. J.

TO OBTAIN a more uniform temperature for the feed water and to eliminate the exhaust steam waste from the open heater I advance the simple idea shown in the sketch. This idea contemplates no change in the present system except for the addition of the vented storage tank over the heater.

In operation the condensate discharged from the vacuum pump in slugs or batches, is piped into the vented storage tank. A gate or globe valve is provided in the connection between the storage tank and the open heater, and this valve may be manually adjusted or throttled so that the rate of flow from the storage tank to the heater is fairly constant even though the condensate is dumped into the storage tank in batches. An overflow pipe is taken from a point near the top of the storage tank and discharged into the heater. This overflow pipe is a safety measure and should not run any condensate unless there is a sudden influx of returns.

The amount of exhaust steam to the heater may be regulated to bring the



Suggested arrangement of receiver and storage tank

boiler feed up to the highest temperature without blowing any steam through the heater vent. This should show a considerable saving provided the heat balance in the plant is such that the exhaust previously wasted may be used elsewhere. Incidentally for each 10 deg. F. increase in feed water temperature approximately 1 per cent coal saving will result.

During the heating season the quantity of returned condensate will vary with the heating load. This will necessitate varying the amount of exhaust steam fed to the open heater. It might be possible to make this function automatic by installing a thermostatically operated valve in the exhaust supply line regulated by the temperature of the boiler feed coming from the open heater. P. L. ULRICH.

Three Rivers, Mich.

THE TROUBLE here hinges upon the fact that the flow of water to the heater is so irregular that part of the time more water is being received than can be heated and part of the time no water at all is being received, allowing exhaust steam to go to waste.

This condition could be partially remedied by throttling the discharge of the condensate pump so that it would deliver water only a little faster than it accumulates. A better feed-water temperature could be obtained while the pump was in operation and the pump would be shut off fewer times per day.

Perhaps the best solution would be to place an insulated water-storage tank at a level above that of the feedwater heater and allow the condensate pump to discharge into this tank at any rate or time interval that is most convenient. The flow of water from the storage tank to the heater could be controlled by a float located in the latter. In this way the rate of water flow into the heater would never exceed the rate of withdrawal by the boiler-feed pump. If care were then used in regulating the boiler feed a practically uniform rate of flow to the heater would be secured and a fairly uniform feedwater temperature maintained. This should result in a marked improvement in plant economy. M. F. KNOY.

Beaumont, Texas.

THE MOST satisfactory results I have had in designing the installation of steam-driven vacuum pumps in conjunction with feed-water heaters such as described in the question, has been from a very simple arrangement. The operation of the pump is quite regular and the exhaust steam has in most all cases been absorbed either by the heating system or the feed water heater.

In a recent installation the system of returns from the low pressure heating system are connected into a 4 in. header to which the vacuum-pump suction was connected through a suction strainer. The steam driven pump controlled in operation by a vacuum pump governor, discharges the condensation into an accumulator tank or receiver. The receiver is located high enough above the feed-water heater to provide gravity drain into the feed-water heater against the maximum internal pressure of the heater.

The receiver is insulated against undue heat loss from the water and is vented to the atmosphere. A definite water volume was established and is maintained in the receiver by the use of an automatic liquid level controller with a float inside the receiver. The make-up water in this case can be either hot or cold, raw or softened as required. The water line in the receiver was established low enough to prevent very little over-flow from the receiver which, of course, called for a fairly large vessel.

The exhaust steam from the vacuum pump as well as that from the boiler feed pumps is collected into a common header after being purified of oil and serves the heating system as well as the feed-water heater and steam coil heaters furnishing hot water for plant service. In addition high pressure steam is reduced in pressure to augment the volume of exhaust steam as requirements demanded larger amounts.

C. F. HOFFMAN.

Toledo, Ohio.

MOST SYSTEMS of this type are handicapped by having the discharge of the vacuum pump enter low on the side of the heater, so that the condensate does not flow through the steam space. This causes a low feed-water temperature, but can be remedied by connecting the pump discharge to the top of the heater where makeup usually enter. This would result in a higher feed temperature and less waste of exhaust steam. Increase in feed temperature may also be secured by better air venting of the heater, but with no sketch of the piping connections available, an exact remedy cannot be suggested. I would prefer no receiver in the pump suction line, but would place one in the pump discharge above the heater so that condensate only, instead of a mixture of air and water, would be delivered to the heater.

A. F. SHEEHAN.

Springfield, Mass.

ASSUMING that the vacuum pump is large enough to handle all the water including the makeup, I would connect the raw water to the receiver tank by the float valve that is now in use and adjust the rod so that no raw water would be cut in until the condensate level in the receiver dropped to the minimum height. I would place a balanced sleeve valve on the feed heater, with a long rod on the float, and a pressure governor on the pump. Then as the water lowered in the heater the pressure would decrease on the discharge side of the vacuum pump and let the pump speed up. The long float rod would give a slower action to the valve, which in turn would give a slow action to the pump governor, thereby eliminate racing of the pump. The pump governor would have to be in accordance with the head now on the discharge side of pump or a little higher. This arrangement would give an even feed-water temperature as well as an even vacuum on the return line. The raw water line should be connected to the discharge line with a valve so it can be opened in case the vacuum pump is shut down. The heater float would control the raw water in the same manner as if it were the condensate.

H. H. FINCH.

Aberdeen, Wash.

A Question for Our Readers

IN MY power plant I have a 2,500-sq.ft. boiler using soft water run at ratings up to 200 per cent. In order to keep the concentration down it is necessary to have a continuous blow from the surface of the boiler through a ¾-in orifice. I have contemplated putting in either a continuous blow or a deconcentrator. The temperature of the water going into the water heater about 7 months of the year averages 50, the other 5 months about 80 deg. F. The deconcentrator manufacturers hold out the advantage of a minimum amount of blowdown, while the continuous blowdown makers claim its advantage as being the transfer of heat from the blowdown of water to the feed water. In my particular case the advantages of the continuous blowdown is very small. For ten to twelve hours a day I have an excess of exhaust in the summer season. Which should work out better? C.F.I.

Suitable answers, if received promptly, will be paid for when published

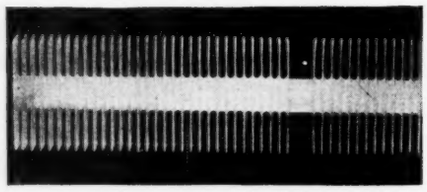
[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehling's *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel-Brabbee's *Heating and Ventilation;* Annett's *Elecctric Elevators.*

WHAT'S NEW IN PLANT EQUIPMENT

New Refrigerating Evaporator Unit

UNUSALLY high efficiency and simplified installation are claimed for the new type of evaporator unit for refrigeration work put out by the Aluminol Products Corporation, 320 Marion Bldg., Cleveland, Ohio. The units are made of a light weight rustless aluminum alloy known as "Aluminol," which is claimed



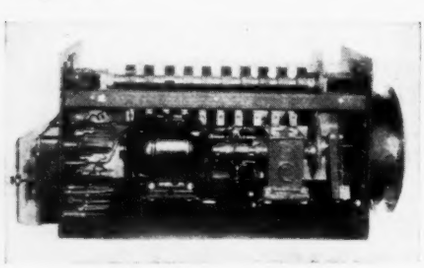
Aluminol evaporator unit

to have a much higher heat transfer efficiency than cast iron or steel and to be suitable for use with either direct-expansion or brine-circulating systems.

The units are cast integrally and when so specified can be cast in multiples of two, three, four or more in one piece. Another feature is the use of tapped holes instead of the usual bolt, gasket and flange connections. The radiating fins on the units are tapered from $\frac{5}{8}$ in. at the base to $\frac{1}{8}$ in. at the top, thus defrosting starts gradually, beginning at the tip and extending to the base. In this way most of the moisture is evaporated back into the storage room. Units cast in multiples of from two up to 120 can be furnished.

Multi-Contact-Making Pressure Gage

A MULTI-CONTACT-MAKING pressure gage for use with supervisory control systems to indicate certain pressure readings at a remote point has been developed by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.



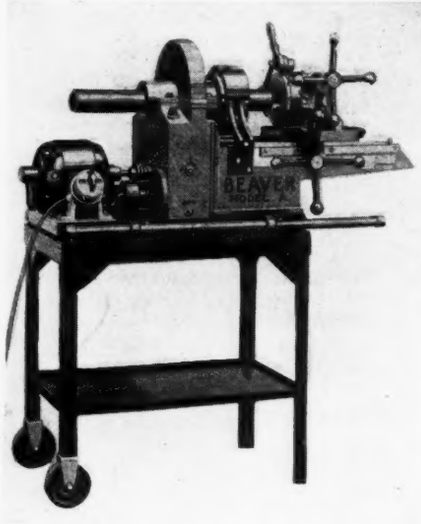
Contact-making pressure gage with cover removed

Ten adjustable contacts are placed at predetermined intervals over the scale of the pressure gage. When the pressure changes sufficiently to make a new contact, a code of impulses is sent over the supervisory control wires to indicate the change. Thus all changes are automatically sent through without the use of extra live wires.

In general, the device consists of motor-driven contacts which are made to follow the pressure gage. To accomplish this the shaft of the pressure gage is extended through to the rear and a contact is mounted on it which will follow the change in pressure. The indicating contacts have a capacity of 5 amp. at 125 volts.

Portable Pipe Machine

DESIGNED to cut, thread and ream $\frac{1}{2}$- to 2-in. steel, wrought-iron, brass or cast-iron pipe the Beaver "Model A" pipe machine put out by the Borden Company, Warren, Ohio, has three



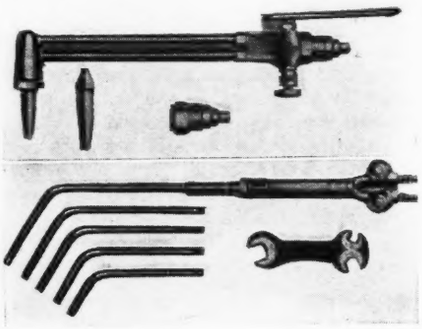
"Model A" Beaver pipe machine

opening die heads that are adjustable for over, under or standard threads. The cut-off follows the design of the standard Beaver square-end pipe cutter.

The machine is driven by a $\frac{1}{2}$-hp. universal motor, reversible at the switch. An oil pump is mounted on the outside for convenience in repacking and cleaning. All main housings are of aluminum. The die head can be tilted back out of the way when cutting and threading up to 12 in., using a universal shaft and geared die stocks and pipe cutters. Bolt die heads can be furnished.

Welding Torch and Cutting Attachment

TWO NEW additions to its line of Purox medium-pressure apparatus for oxy-acetylene welding and cutting has been made by the Linde Air Products Company, 30 East 42d St., New York. The Purox No. 11 welding torch, which supersedes the No. 10, has a wide veld-



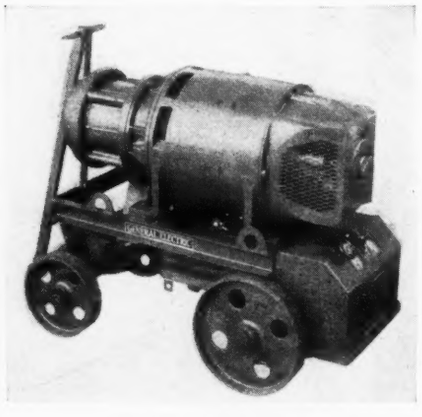
No. 21 cutting attachment and No. 11 welding torch

ing range extending from the lightest sheet metal up to work as heavy as $\frac{1}{2}$-in. plate. The tips are of one-piece, hard-drawn copper construction and are so designed that the head angle can be easily adjusted as desired by the user. Tips No. 2, 4, 6, 8 and 10 are furnished as standard equipment.

The Purox No. 21 cutting attachment designed for use with the Purox No. 11 welding torch will cut metal up to 2 in. in thickness. It is furnished with one- and two-piece cutting tips. By means of this cutting attachment the welding torch can be readily converted into a cutting torch.

Single-Operator Welding Set

THE NEW LINE of single-operator welding sets designated WD-20, put out by the General Electric Company, Schenectady, N. Y., includes both portable



WD-20 welding unit

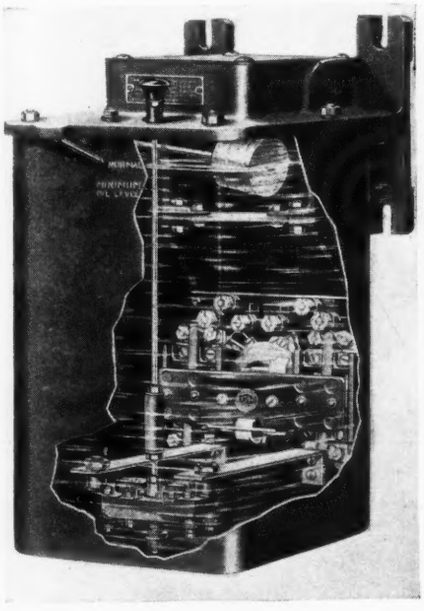
and stationary sets. Types include those for operation on either alternating or direct current at all standard

voltages, and, in the case of alternating current, standard frequencies. Two- and three-phase gasoline-engine-driven sets are also available.

Among the principal advantages claimed for the line are the use of two-bearing construction on the alternating-current types up to 600 amp.; compactness and light weight; and greatly improved welding characteristics. The sets are self-excited, with a tapped series field for major current adjustments and a shunt field rheostat giving duplex voltage control.

Explosion-Proof Starter for Hazardous Locations

DISTINGUISHING this explosion-proof, across-the-line, automatic starter for alternating-current squirrel-cage induction motors from similar explosion-proof equipment is the immersion in oil



Automatic starter for hazardous locations

of the thermal-overload mechanism. It differs from the usual immersed-oil dashpot relay and three-pole magnetic contactor in that a newly designed thermal-overload mechanism is used with the contactor. The starter is designed to meet the latest requirements of the Underwriters Laboratories for Class 1, Group D, Hazardous Locations.

The contacts open under a 6-in. head of oil. A special provision is made for bringing all incoming wires to the terminals below the oil level. Threaded conduit openings and a compound filled junction box are included. Being completely oil-immersed, the starter is corrosion-resisting and therefore suitable for chemical plants and cement mills as well as a wide range of other applications. The starter is a recent product of Cutler-Hammer, Inc., 294 North 12th St., Milwaukee, Wis.

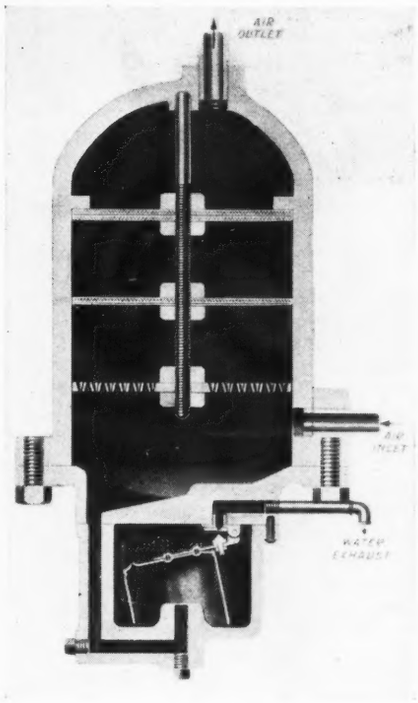
Protective Coating

A PROTECTIVE COATING which may be applied by gun or by brush to hot or cold surfaces has been announced by the Liquilox Company, Ltd., 576 Subway Terminal Bldg., Los Angeles, Calif. This protective coating is said to contain no dyes, lamp black, rosin, asphalt, vegetable or animal oils, and offers protection against all acids, alkalies, salts, and indirect heats from 1,400 to 1,500 deg. F. It is for application to woods, fabrics, metals and stone. The color is black, although other shades ranging mostly to variations of bronze are available on special order.

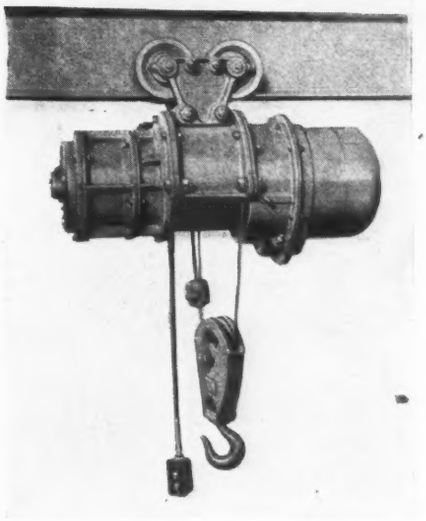
Water and Oil Separator for Compressed-Air Lines

TO PROVIDE a practical means of removing water and oil from compressed-air lines the separator "Dryair" shown in the accompanying illustration has been introduced by James A. Murphy & Company, Hamilton, Ohio.

Air enters the separator at the bottom at a tangent, giving it a whirling motion, which action precipitates a large percentage of the moisture. From this lower chamber to the outlet the air passes through three baffles, two of which are made of finely graduated bronze screening and spaced in the body as shown. The moisture particles removed from the air, fall to the bottom and pass to an automatic trap incorporated in a separate chamber. The housing is made of cast iron, and all baffles and inner parts except the valves are of bronze. The valve and valve seat are of a special chrome steel.



Cross-section of separator



Wright trolley hoist

Electric Trolley Hoists

PLAIN, geared, and motor-driven trolley types are included in the new line of electric trolley hoists put out by the Wright Manufacturing Company, Bridgeport, Conn. The bearings of the trolley wheels are designed to absorb both radial and thrust loads.

In the motor-driven trolleys the wheels are driven on each side of the I-beam and are equipped with a safety stop. Controllers for single-speed, two-speed or variable-speed can be furnished.

The hoists can be mounted either parallel or at right angles to the runway beam. While the standard lift is 18 ft., lifts of 9 and 36 ft. can be furnished. Other features of the hoist machine are full size drums for long cable life, push-button or pendant rope control, Tru-Lay preformed cable, safety-type limit switch, positive braking and weather-proof motors.

Low-Melting-Point Brazing Alloy

A NEW brazing alloy known as Sil-Fos and containing a small percentage of silver is announced by Handy & Harman, 57 William St., New York City.

Low melting point of 1,300 deg. F. is an important characteristic of the new alloy. This permits brazing and welding without the danger of weakening, distorting or destroying the parts adjacent to the joint. It is also said to possess free-flowing properties with deep and quick penetration, and to require less than the usual amount of flux, owing to the deoxidizing effect of the phosphorous in the alloy. The alloy can be used for joining brass, bronze, nickel, nickel bronze, Monel metal and other metals and alloys fusing at about 1,300 degrees.

NEWS of the FIELD

New 115,000-Kw. Turbine-Generator Placed In Operation at Waukegan Steam Station

UNIT 5, a new 115,000-kw. turbine-generator, has just been placed in operation in the Waukegan steam station of the Public Service Company of Northern Illinois. This brings the total station capacity to 290,000 kw. Unit 5, like the other four units, was designed and built by the Allis-Chalmers Company, and it is the largest machine completed by the manufacturer to date. The turbine itself is of the Parsons tandem-compound type similar in design to Unit 4.

Three boilers burning pulverized fuel have been installed in connection with Unit 5. Two of the new boilers are of the standard type with a normal capacity of evaporating 360,000 lb. of water per hour and a maximum rated capacity of 495,000 lb. per hour. The third boiler serves a dual purpose. It is used to reheat steam taken from the turbine and to generate live steam in a separate live steam section. The reheat section will reheat a maximum of 930,000 lb. per hour and the live steam section has a normal rated capacity of 265,000 lb. of steam per hour with a maximum of 300,000 lb. of steam per hour.

All boilers are of the single-pass horizontal cross-drum type, each having a superheater, air heater, economizer and water-cooled furnace walls. The economizer on the reheat boiler is about one-third the size of the economizer on the standard boilers, the reheater taking up the remaining space. All raw water used in the boilers is evaporated in a two-stage evaporator capable of handling 77,000 lb. of water per hour.

Each boiler is equipped with three ball mills capable of pulverizing fourteen tons of coal per hour.

The steam from the standard boilers and the "live steam" section of the reheat boiler enters the throttle of the turbine at 625 lb. pressure and 750 deg. F. It is then passed back to the reheat portion of the reheat boiler where its temperature is raised again to 750 deg. F., after which it is then returned to the turbine.

Directly connected to and underneath the turbine is the condenser with 80,000 sq.ft. of condenser surface capable of condensing 900,000 lb. of steam per hour. Under full load conditions, 132,000 gal. of cooling water per minute are pumped from Lake Michigan through it and returned to the lake.

Energy is taken from the generator at 18,000 volts direct to three 40,000 kva. transformers, where it is raised to 132,000 volts. The greater part of the energy taken from Station 6 is transmitted considerable distances over the company's steel tower transmission lines to centers of lower voltage transmission and distribution. The rest of the energy is transmitted over lower voltage lines to nearby cities.

To effect economies in handling the large quantities of coal necessary for the operation of the enlarged station, a car dumper has been installed capable of handling twenty cars of coal per hour. Each car of coal is pushed up an incline track by electric drive, is clamped in position, turned completely over, dumping its contents, and then descends on the inclined track on the side opposite the approach. The entire conveyor system has been speeded up so as to be able to handle 400 tons of coal per hour.

State Engineering Examiners Adopt Standard Test System

REAFFIRMING its belief in the essential unity of the engineering profession, the National Council of State Boards of Engineering Examiners passed a resolution opposing any legislation tending to break down the solidarity of the profession and adopted a standard system of examinations for the registration of engineers at its twelth annual convention held in Detroit, Mich., on Oct. 1 to 3, inclusive.

As adopted, the standard system provides that written examinations be required for the registration of all professional engineers with the exception of those whose experience and qualifications are outstanding. Three-fourths of the examination shall be uniform for all applicants, with a fourth differentiated for the major branches of civil, mechanical, electrical, mining and chemical engineering. The written examinations are to test the basic knowledge of fundamental mathematical and physical principles underlying all engineering work, the general knowledge of the common essentials of all branches of engineering and a more thorough knowledge of one major branch. Provision is made for oral examinations and the optional submission of a thesis.

Eighteen states and five national engineering societies—the A.E.C., A.S.C.E., A.S.M.E., A.I.E.E. and A.A.E.—were represented at the convention, which had the largest attendance of any meeting held by the organization. It was reported that 24 states now require the registration of engineers, and all of these states are members of the National Council. T. Keith Legaré was appointed as a representative of the council on a joint committee of the national societies to continue the council's work on a uniform registration law. The council approved the establishment of a national bureau of engineering registration and appointed a committee to work out the details of organization.

P.R.R. Signs Large Contract With Baltimore Utility

A CONTRACT to supply all the electric power required by the Pennsylvania Railroad for use from the Susquehanna River to Havre de Grace, Md., has been given to the Consolidated Gas, Electric Light & Power Company of Baltimore.

This contract, one of the largest sales of power ever made at one time, will run twenty years. The supplying of power will start early in 1933 and will be increased as electrification develops on this and adjoining sections of the railroad.

The power will be supplied by the Consolidated Gas of Baltimore and its two affiliates, the Pennsylvania Water Power Company and the Safe Harbor Water Power Corporation, which will have, on completion in the near future of the initial installation of the Safe Harbor project, a combined steam and hydro-generating capacity of more than 750,000 horsepower.

First Tunnel "Holed Through" at Hoover Dam

CONTRACTORS at Black Canyon, according to reports of R. F. Walter, chief engineer of the Reclamation Service to Secretary Wilbur, have "holed through" on the pioneer bore of the first of the great tunnels which are to carry the flow of the Colorado River while Hoover Dam is being built.

In a single day recently, he reports further, the crews working at eleven different heads, drilled and excavated a total of 163 linear feet of tunnel.

As a matter of fact the task of driving

four tunnels, each 50 ft. across and each practically a mile long, one of the major undertakings of the whole enterprise, is in this way shown to be well under way and progressing rapidly. With but a year of work, most of it preliminary, Mr. Walter says, the contractors are today six months ahead of their schedule.

In constructing each of these 50-ft. tunnels the first task is to run a 12-ft. tunnel all the way through on what is to be the floor of the big tunnel. This makes it possible then to bring down the 38 ft. of rock that must be removed in creating the 50-ft. tunnel and load it on cars for removal with the expenditure of a minimum of energy.

A.I.E.E. Southwest Meeting In Kansas City, Oct. 22-24

THE SOUTHWEST DISTRICT of the American Institute of Electrical Engineers will hold a three-day meeting in Kansas City, Mo., on Oct. 22 to 24, with headquarters at the Kansas City Athletic Club. The local committee has arranged a program consisting of four technical sessions, interesting inspection trips, a banquet and special entertainment features. In addition to the papers which will be given and supplementing the visit to Bagnell Dam, a three-reel motion picture of the actual construction of this huge hydro-electric development will be shown.

Among the papers to be presented are: "The Effect of Wave Form on the Operation of Induction-Type Protective Relays," P. H. Robinson; "Backfires in Mercury-Arc Rectifiers," J. Slepian and L. R. Ludwig; "Overvoltages on Transmission Systems Caused by Dropping of Load," E. J. Burnham; "Interconnection of the 25- and 60-Cycle Systems of the Union Electric Light & Power Company," E. C. Hough and L. V. Nelson; "Automatic Control for Variable-Ratio Frequency Converters," E. K. Shively and G. S. Whitlow.

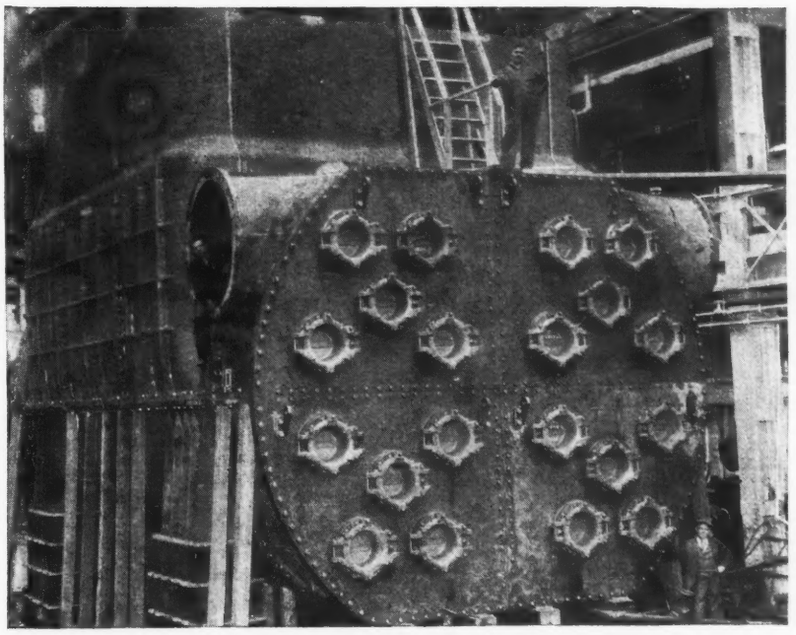
Permit P. G. & E. to Issue More Bonds for Expansion

PERMISSION has been granted by the California Railroad Commission to the Pacific Gas & Electric Company and the Mt. Shasta Power Corporation, its subsidiary, to increase its bonded indebtedness from $250,000,000 to $500,000,000 and to execute a supplemental indenture to this extent.

Last June the proposed increase was approved by the stockholders and at the time the application was made to the Railroad Commission, the statement was made that the step was being taken in order to take care of future financial requirements as "applicants in the conduct of their several public utility enterprises are under the necessity of raising large sums of money for the purchase, acquisition and construction of additions, extensions and improvements to their properties."

In authorizing the increase, the Railroad Commission stated that the P. G. & E. "does not at this time ask permission to issue any bonds. The indenture makes no changes in the company's first and refunding mortgage or deed of trust supplemental indenture, except increasing the amount of bonds which may be issued under such instrument."

LARGEST SURFACE CONDENSER



The world's largest single-shell surface condenser has just been installed in the Hudson Avenue Station of the Brooklyn Edison Company, to receive steam from a 160,000-kw. turbine-generator. Manufactured by the Worthington Pump & Machinery Corporation, the new condenser has a condensing surface of 101,000 sq.ft. It is 34 ft. high, weighs approximately 608 tons and contains 84 miles of 7/8-in. tubing.

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Commission Evolves New Plan for Muscle Shoals

THE MUSCLE SHOALS COMMISSION is adhering to its original purpose of working out "a fair, sound and feasible plan" for Muscle Shoals according to a statement made public Oct. 5 on behalf of the commission by Col. Joseph I. McMullen, who represents the Department of War on the Commission.

Recent impressions that the commission contemplated leasing or sale of the property without further action by Congress are erroneous, according to the statement.

Colonel McMullen, who just returned from meetings of the commission held at Birmingham, Ala., also disclosed a tentative three-fold plan evolved by the commission for the operation of Muscle Shoals. It includes the production of fertilizer, the development of scientific methods to improve soil fertility and the establishment of chemical industries.

Plan 50,000-hp. Addition to Seal Beach Steam Station

PLANS for the installation of a 50,000-hp. generating unit in the Seal Beach, Calif., steam-electric plant of the Los Angeles Gas & Electric Corporation have been announced by Addison B. Day, president and general manager of the corporation. The new unit, to be built at a cost of $3,500,000, will bring the capacity of the station to 148,000 hp. Mr. Day announced that work on the addition would be started about Jan. 1, 1932. Continued growth of the corporation's electrical business, he said, necessitates planning for the new unit at this time.

Work to be done in connection with installation of the new generating unit includes the construction of a 117 ft. by 168 ft. addition to the present Seal Beach station building to house the unit, construction of a new transmission line from the station to the corporation's Eastside substation in Los Angeles, and the necessary enlargement of this substation to care for the new high line and the additional load.

The new unit at the Seal Beach station will be the third installed since establishment of the station in June, 1925. Capacity of the first unit was 48,000 hp. A second unit of 50,000 hp. was installed in August, 1928. The investment represented in the station will be brought to approximately $12,000,000 with completion of the new unit, Mr. Day said.

News of Canada

Saskatchewan development to cost $18,000,000; start new study of Passamaquoddy plan; Ont. Hydro buys more power

THE PROVINCE of Saskatchewan's projected hydro-electric power scheme, with the Saskatchewan River, east of Prince Albert, as the source of supply, will involve preliminary capital expenditure of $15,000,000 and an additional $3,000,000 a few years later, according to a report submitted by H. G. Acres, of Toronto, the expert appointed by the Saskatchewan government to investigate the project. The report indicates that sufficient power can be generated by Horseshoe Bend to take care of the maximum requirements of the cities of Regina, Saskatoon, Moose Jaw and Prince Albert for a number of years before it would be necessary to resort to the use of steam as supplemental power for periods of maximum demand.

In the meantime, southern Saskatchewan gains a large amount of new power with the recent bringing into operation of the new 10,000-kw. turbine-generator of the National Light & Power Company, installed at Moose Jaw.

JOINT INVESTIGATION by United States and Canada of the probable effect upon fisheries of the projected power development scheme across Passamaquoddy Bay between Maine and New Brunswick, was set in motion at Ottawa on Sept. 30. A program of extensive researches, carried on by a group of associated experts was mapped out and approved by a commission appointed by the two countries. The power development scheme has been under consideration for a number of years, a company having received charters in both the United States and Canada. About two years ago, when the company sought an extension of the time in which to commence operations, the Canadian government demurred until the probable effect on fisheries should be ascertained. This led to the constitution of the commission, the cost of which will be borne by the two countries.

WITH THE COMPLETION of the Abitibi Canyon power project in Northern Ontario not expected now until the fall of 1932, the Ontario Hydro Electric Power Commission by reason of the delay in construction has found it necessary to enter into a supplementary agreement with the Ontario Power Service Corporation to supply, for the time being, to the Sudbury mining district, from the corporation's existing development of the Abitibi Power & Paper Company at Island Falls, the electrical energy that was to have been available from the Canyon enterprise. The substitute power is being transmitted to the International Nickel Company at Copper Cliff, which had a contract with the Power Commission, calling for delivery on Oct. 1, 1931, of a first minimum block of 16,000 hp. The power will be continued in such quantities as the Sudbury district may require (up to 25,000 hp.) until the Canyon development is completed, about a year from now.

COMING CONVENTIONS

American Society of Mechanical Engineers. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Kansas City, Mo., Oct. 22-24. Annual winter convention in New York City, Jan. 25-29, 1932. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Society of Refrigerating Engineers. Joint meeting with the A.S.H.V.E. and annual convention at the Hotel Cleveland, Cleveland, Ohio, Jan. 26-29, 1932. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Water Works Association. Annual convention at the Hotel Peabody, Memphis, Tenn., May 2-6, 1932. Secretary, Beekman C. Little, 29 West 39th St., New York City.

National Association Practical Refrigerating Engineers. Annual convention and exhibition at the Municipal Auditorium, Houston, Tex., Nov. 10-13. Secretary, Edward H. Fox, 435 North Waller Ave., Chicago, Ill.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

N. Y. Purchasing Agents to Hold Machinery Exhibit

AS A STIMULUS to the somewhat more optimistic note in business the firms represented in the membership of the Purchasing Agents Association of New York will hold an exhibition of products in the Roof Garden of the Pennsylvania Hotel on Tuesday, Nov. 17.

The exhibition, which is an innovation with the purchasing agents of the metropolitan district, will have more than one hundred exhibitors in a wide range of products, machinery and service. No charge for space will be made but exhibit will be confined to firms represented in the membership of the association. Displays of power generating equipment, pumps, conveyors, instruments and electrical apparatus will be included in the exhibits.

The exhibition will be held in conjunction with the November dinner-meeting of the association.

Personals

F. SAMUELSON, of the British Thomson-Houston Company, Ltd., Rugby, England, arrived in this country recently to study power developments here. After visiting some of the larger steam stations in New York City, he went to Detroit, Mich., where he is now inspecting the new high-pressure turbine installation of the Detroit Edison Company, which was manufactured by his company.

MELVIN SACK, formerly connected with the C. H. Wheeler Manufacturing Company, Philadelphia, Pa., as a specialist on heat exchangers, has joined the engineering staff of the Henry Vogt Machine Company, Louisville, Ky. In his new position Mr. Sack has charge of the department of heat-exchanger design.

CHARLES L. EDGAR, president of the Edison Electric Illuminating Company of Boston, has been elected chairman of the executive committee of the Society for Electrical Development. Mr. Edgar is a former president of that organization. J. J. CADDINGTON, who is also connected with the Boston Edison company, has been elected a director of the society. He is secretary of the Metropolitan Electrical League of Boston.

W. RAYNER STRAUS, who has held various engineering positions with the municipal government of Baltimore, Md., has been appointed head of the Bureau of Mechanical-Electrical Service of that city. This bureau is one of those included in the Department of Public Works.

ERLE K. RAMSEY, of Oklahoma City, Okla., was elected president of the American Association of Engineers at the association's seventeenth annual meeting held in Huntington, W. Va., on Sept. 27 to 30. Other officers elected are: vice-president, VIC H. HOUSHOLDER, Phoenix, Ariz.; secretary, M. E. McIVER, Oak Park, Ill.; and treasurer, H. W. CLAUSEN, Chicago, Ill.

SIMS ELY, of Arizona, has been appointed by Secretary of the Interior Wilbur city manager of Boulder City, Nev., the new town which is to be the place of abode of the workers who will build Hoover Dam and appurtenant works. Mr. Ely has held responsible municipal positions in Arizona and was identified with the preliminary work leading to the Colorado River Compact Commission. He will undertake the organization of Boulder City and its operation during the years Hoover Dam is being constructed. He will be responsible and report to Construction Engineer WALKER R. YOUNG, who is in charge of the project.

A. W. CONOVER has been appointed general manager of the Oklahoma-Kansas division of the Empire Public Service Company, which serves central and northern Oklahoma and the southeastern part of Kansas.

Business Notes

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, East Pittsburgh, Pa., announces a reorganization of its industrial sales department, under the direction of O. F. Stroman, to effectively serve the electrical requirements of all industries. Two assistant sales managers and fourteen divisional managers have been appointed. Bernard Lester and C. B. Stainback are the new assistant sales managers, under whom are the division managers: G. D. Bowne, general mill electrification; J. W. Speer, machinery electrification; G. E. Stoltz, mining and metal working; E. B. Bremer, appliance electrification; E. F. Mead, general industrial resale; J. R. Olnhausen, medium a.c. motors; R. M. Davis, medium d.c. motors; R. O. Watson, large motors; D. H. Byerly, small motors; W. W. Reddie, welding; T. C. Kelley, industrial heating apparatus; W. G. Balph, safety switches; W. H. McGillivray, controllers; and F. W. Horst, costs.

FOSTER WHEELER CORPORATION, New York City, announces the appointment of H. L. Robinson as general sales manager. Mr. Robinson has long been associated with Foster Wheeler interests, having joined the Wheeler Condenser & Engineering Company prior to the formation of the Foster Wheeler Corporation.

DUNBAR ENGINEERING COMPANY, New York sales representative for the EDWARD VALVE & MANUFACTURING COMPANY, East Chicago, Ind., announces the opening of a Philadelphia office in the Witherspoon Building. The company states that the new office will be under the management of Lee W. Tremblay.

REPUBLIC STEEL CORPORATION, Youngstown, Ohio, has appointed William T. Bentz manager of sales of rail steel products, according to an announcement made by N. J. Clarke, vice-president in charge of sales. Mr. Bentz was formerly sales head of Steel and Tubes, Inc., a Republic subsidiary, where he had many years' experience in the manufacture and sales of hard steel products. He will continue for the present to make his headquarters in Cleveland.

COEN COMPANY, INC., announces the removal of its offices and warehouse to 915 Bryant St., San Francisco, Calif. Other offices of the company are located in Los Angeles; Houston, Tex.; and New York City.

MINNEAPOLIS-HONEYWELL REGULATOR COMPANY, Minneapolis, Minn., announces the inauguration of a second series of radio broadcasts dedicated to the wonders which modern engineering has accomplished in the automatic control of heat, cold and pressure. Known as "The Wonder Hour," this broadcast will feature musical programs of instrumental and vocal numbers.

How's Business?

DOMESTIC BUSINESS indicators show no definite turn for the better, but despite the absence of any sign of seasonal stimulation they still hold slightly above the bottom established by basic consumpiton requirements, according to *The Business Week* for Oct. 14. Considering the depths to which the deflation process has been pushed, it is plausible to expect that the developments of the next few months will mark the turning point of the depression if domestic and international leadership is at last mobilized for aggressive action.

Production of electricity by public utilities for the week ended Oct. 3 was 1,645,587,000 kw.-hr., a decrease of 3.8 per cent below the output for the corresponding period of 1930, according to N.E.L.A. figures. Compared with the week ended Sept. 26, production showed a decline of about 1 per cent.

Trade Catalogs

BOILERS, ECONOMIZERS, STOKERS — Four new illustrated bulletins covering boilers, economizers, stokers and marine propulsion, respectively, have just been issued by the Babcock & Wilcox Company, 85 Liberty St., New York City. The first contains a full description, with installation plans, of the Type H Stirling boiler. All construction details of return-bend economizers are described in the second bulletin. The third contains information on a line of chain-grate stokers for various types of boilers. The fourth bulletin outlines in non-technical language the evolution of marine steam propulsion from low-pressure plants to the present economical use of "Modern Steam."

PUMPS—Single-stage, double-suction centrifugal pumps of the horizontally split casing design are described and illustrated in Catalog B-2, recently published by the De Laval Steam Turbine Company, Trenton, N. J. Another new publication of the company, entitled "Converted Steamship City of Baltimore," describes the modernization of a marine power plant.

CONDENSERS, HEAT EXCHANGERS — Bulletin G-3 just issued by the Elliott Company, Jeannette, Pa., describes and illustrates distillation equipment used in various manufacturing processes. It covers fractionating columns, tubular condensers, heat exchangers, steam jet ejectors and barometric condensers.

BELTING—J. E. Rhoads & Sons, 35 North Sixth St., Philadelphia, Pa., have just issued the ninth edition of their "Belt User's Book." This handy pocket reference contains useful rules, tables and charts for the installation, operation and maintenance of leather belting.

WATER COOLING—The many applications of water-cooling systems to power and industrial plants are described and illustrated in Bulletin 6-E recently published by the Binks Manufacturing Company, 3114-40 Carroll Ave., Chicago, Ill. Full details are given on both spray ponds and cooling towers.

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Fuel Prices

FUEL OIL

Boston—Oct. 6, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.87c. per gal.; 28@32 deg., 4.83c. per gal.

New York—(Oct. 1) Industrial use, f.o.b. harbor, tank cars or boats, per barrel of 42 gal.: Bunker C, 70c., terminal; Diesel, $1.40, refinery.

Tank-wagon delivery, per gal.: No. 5 (18@20 deg.), $4.25c.; No. 6 (14@16 deg.), 3.5c.

Philadelphia — Sept. 27, tank-wagon delivery, No. 3 industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—Sept. 29, f.o.b. local refinery, fuel oil, 36@40 deg., 2.5c.@2.75c. per gal.

Cincinnati — Sept. 29, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Sept. 28, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@2 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5c. per bbl.; 28@30 deg., 37.5c. per bbl.

St. Louis — Sept. 29,, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.02 per bbl., or 42 gal.; 26@28 deg., $1.095 per bbl.; 28@30 deg., $1.195 per bbl.; 30@32 deg., $1.245 per bbl.; 32@36 deg., gas oil, 2.776c. per gal.; 36@38 deg., distillate, 3.151c. per gal.

Dallas—Oct. 3, f.o.b. local refinery, 24@26 deg., 70c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Clearfield, mine-run....	New York.	$1.50@$1.75
Pittsburgh, mine-run...	Pittsburgh.	1.20@ 1.50
Pittsburgh, st. slack...	Pittsburgh.	.55@ .60
Smokeless, mine-run....	Chicago...	1.75@ 2.00
Smokeless, slack.....	Chicago...	.40@ 1.00
Harlan, Ky., slack.....	Chicago...	.60@ .90
Franklin, Ill., mine-run	Chicago...	2.15
Franklin, Ill., screen....	Chicago...	1.10@ 1.60
Ind. 5th Vein, m.-r....	Chicago...	1.20@ 1.75
Standard Ill., mine-run	St. Louis...	1.30@ 1.50
W. Ky., mine-run.....	Louisville..	.85@ 1.30
W. Ky., slack.....	Louisville..	.35
Fairmont, mine run....	Fairmont..	.90@ 1.05
Fairmont, slack.....	Fairmont..	.50@ .85
Smokeless, mine-run...	Cincinnati.	1.60@ 2.00
Smokeless, slack.....	Cincinnati.	.35@ .75
Kanawha, mine-run....	Cincinnati.	1.00@ 1.25
Kanawha, nut-slack...	Cincinnati.	.35@ .50

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat.....	New York.	$3.25
Rice.....	New York.	1.85
Barley.....	New York.	.90@ 1.40

NEW PLANT CONSTRUCTION

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—City plans the construction of Section 1 and 2 and Unit No. 3 of Wilmington Intercepting sewage system, including pumping plant, etc., also Venice Outfall sewage pumping plant. Estimated total cost $376,560.

Calif., North Sacramento—City is having surveys made for a municipal waterworks system including pumps, etc. Estimated cost $60,000. C. Knight is city engineer.

Calif., Seal Beach—Los Angeles Gas & Electric Co., 810 South Flower St., Los Angeles, plans a large addition to generating plant here. Maturity early 1933.

Conn., Hamden (br. New Haven)—City awarded contract for the construction of a pumping station and overflow basins for completion of Spring Glen project to Charles Smith & Sons, Inc., 101 Water St., Derby.

Ind., Hartford City—School Commissioners, awarded contract for a new steam heating plant in Township School, Blackford County, to Hartford Hardware Co., Hartford City. Estimated cost $40,000. Boilers and equipment will be required.

Ind., Pendleton—Indiana State Reformatory, R. Howard, Supt., plans the construction of a 3 story, 80 x 160 ft. heating plant and trade school. Estimated cost $90,000. Private plans.

Ind., Wapaw—City is having plans prepared for the construction of a municipal light plant. Estimated cost $100,000. C. W. House is engineer.

Mass., Boston—Hospital Dept., awarded contract for oil pump and heating equipment for power plant at City Hospital to J. J. Hurley & Co., 104 Broadway.

Mass., Boston — New England Hospital for Women, 40-50 Dimock St., awarded contract for addition to boiler room to D. H. Jacobs & Sons, 77 Summer St. Estimated cost $40,000.

Mass., Holyoke—City, awarded contract for two centrifugal pumps for Homestead Ave. pumphouse to Worthington Pump & Machinery Corp., 37 Appleton St., Holyoke.

Mass., Williamstown—Williamstown College, Main St., will soon award contract for the construction of a power plant. Estimated cost $45,000. Densmore, Le Clear & Robbins, 31 St. James Ave., Boston, are engineers.

Minn., Minneapolis—Commander Milling Co., J. W. Jolly, Secy., 661 Chamber of Commerce Bldg., awarded contract for the installation of three 800 hp. Diesel generating units and two 500 hp. synchronous motors in power plant at 34th St. and Hiawatha Ave. to Fairbanks, Morse & Co., Park Sq., St. Paul.

Mont., Great Falls—City will soon award contract for addition to pump house at waterworks plant. Estimated cost $25,000. E. Henen is city engineer.

Neb., Grand Island—City, c/o J. E. Clifford, Clk., will soon award contract for addition to waterworks and power plant building. Estimated cost $18,000. Arthur D. Baker, Clinic Bldg., is engineer.

Neb., Omaha—State Board of Control, State Capitol, Lincoln, awarded contract for two water tube boilers including breeching, soot blowers, feed water regulators, oil burning equipment, etc., at School for Deaf here, to J. F. Pritchard & Co., Dwight Bldg., Kansas City, Mo. $18,510.

N. J., Wayne—Board of Chosen Freeholders, Court House, Paterson, plans the installation of a new waterworks system at Valley View county grounds to include pumping station, etc. Estimated cost $50,000. Garwood Ferguson, Court House, Paterson, is engineer.

N. Y., Brooklyn — Paramount Ice Co., 89 Steuben St., plans the construction of a 75 x 100 ft. ice storage plant at Emerson Pl. and Myrtle Ave. Estimated cost $60,000. G. J. Lobenstein, 885 Flatbush Ave., is architect.

N. Y., Geneseo—Dept. of Education, Education Bldg., Albany, awarded contract for boiler plant and service connections to C. A. Foote & Sons, Mount Morris, also heating to Barr & Creelman, 74 Exchange Pl., Rochester. Total cost $16,997.

N. Y., New York—Dept. of Hospitals, Municipal Bldg., awarded contract for alterations and additions to boiler house and installation of new boilers in City Home District, Welfare Island to K. W. Hanson, 381 Fulton St., Brooklyn, $21,995.

N. Y., New York—New York Edison Co., 4 Irving Pl., awarded contract for addition to power plant and boiler house, to Kennwell Construction Co., 45 East 17th St.

N. D., Grafton—State Board of Administration, E. G. Wanner, Secy., Bismarck, will receive bids until Oct. 27 for addition to heating and power plant at State Institution for Feeble Minded. Estimated cost $150,000. T. B. Wells, Grand Forks, is engineer.

R. I., Newport — City, F. M. Sisson, City Hall, is receiving bids for the construction of pumping stations at Waterworks Road and Marchant St. $15,000.

S. C., Columbia — Veterans' Administration, Arlington Bldg., Washington, D. C., will receive bids until Nov. 10 for the construction of a group of buildings, including refrigeration and ice-makng plant, steam and electric distribution systems, etc., at Veterans' Administration Hospital here.

Tex., Crystal City—City voted $128,000 bonds for the construction of a light and power plant.

Tex., Fort Sam Houston — A. S. Harrison, Constructing Quartermaster, awarded contract for the construction of a group of buildings including 447 x 560 ft. engineering shops, 66 x 260 ft. dope house, 10 x 50 ft. boiler house, etc., at Duncan Field, to A. J. Rife Construction Co., 1913 North Harwood St., Dallas, $679,000.

Utah, Lehi—City awarded contract for one 180 and one 210 hp. Diesel engines together with switchboard, etc., in connection with proposed additions to electric light plant to Fairbanks Morse & Co., 14 S.W.T. Bldg., Salt Lake City.

Ont., Bronte—Water Commission, plans extensions and improvements to waterworks system, including pumphouse, mains, etc. Estimated cost $100,000. G. H. Powers, 53 Brant St., Burlington, is engineer.

Ont., Wiarton—Town awarded contract for pump well and intake to William Clark & Son, Owen Sound, pump, electric motor and pumping equipment, to Turbine Equipment Co., 73 King St. W., Toronto, gasoline engine and pump to Goldie & McCullach, Galt. Estimated cost $15,000.

Equipment Wanted

Pump—Coalinga, Calif.—City, E. J. McCroskey, Clk., will receive bids until Oct. 19 for a 1,000 g.p.m. deep well turbine pump, with motor in connection with waterworks.

Pumps and Motors—Sacramento, Calif.—City plans to purchase pumps and motors for pretreatment works at municipal filtration plant in connection with waterworks.

Pump — Sunnyvale, Calif. — Twelfth Naval District, 100 Harrison St., San Francisco, will receive bids until Oct. 21 for furnishing and installing pump, also reconditioning and resetting motor and water pump now on site in connection with proposed waterworks improvements here.

Condenser—New York, N. Y.—Dept. of Hospitals, Municipal Bldg., will receive bids until Oct. 19 for furnishing and installing a surface condenser in power house at Bellevue Hospital.

Pumps, Motors, etc.—Munhall, Pa.—Borough of Munhall, plans to purchase pumps, motors, etc., in connection with waterworks improvements. Estimated cost $25,000.

Pumps, etc.—Menomonie Falls, Wis.—City plans to purchase deep well turbine pump, centrifugal booster pump, etc., for proposed waterworks improvements. Estimated cost $20,000.

Pumps, etc.—Kirkland Lake, Ont.—Township of Teck, J. W. McBain, Clk., will receive bids until Oct. 15 for motor driven centrifugal pumps and standpipe, in connection with waterworks. Estimated total cost $85,000.

Pumping Plant—Invercargill, N. Z.—City Clerk, will receive bids until Oct. 28 for the construction of a centrifugal low-lift pumping plant with motor and control gear.

Industrial Projects

Ala., Mobile — Coastal Petroleum Corp., awarded contract for the construction of a refinery, 5,700 bbl. daily capacity at Blakely Island to J. T. Devine Mfg. Co., Mount Vernon, Ill., and 25 West 43rd St., New York. Will use Pratt vapor phase cracking process.

Calif., Alameda—Owens-Illinois Glass Co., W. I. Cole, Mgr., 133 Kearny St., San Francisco, is having plans prepared for the construction of a glass factory here. Estimated cost $1,000,000. Mills, Rhines, Bellman & Nordhoff, Inc., Ohio Bldg., Toledo, O., are architects.

Calif., Bay Point—Congoleum-Nairn Inc., 195 Belgrove Dr., Kearny, N. J., is having preliminary studies made by Sanderson & Porter, 52 William St., New York, N. Y., Engrs., for a factory for the manufacture of linoleum, felt base floor covering, etc., including power plant here. Estimated cost to exceed $1,000,000.

Calif. Santa Ana—Pittsburg Plate Glass Co. Grant Bldg. Pittsburgh, Pa., awarded contract for the construction of a glass plant at Fairview and Bristol Sts. here to Stone & Webster Engineering Corp., 601 West 5th St., Los Angeles. Estimated cost $4,000,000.

Idaho, Priest River—Pacific States Pulp & Paper Co., c/o E. Van Winkle, Secy., 414 Fernell Bldg., Spokane, Wash., plans the construction of first unit of plant for the manufacture of salt cake for paper pulp here. $50,000. Total estimated cost $1,000,000. Architect not announced.

Ind., Columbia City — Globe-Superior Co., awarded contract for a 2 story, 80 x 200 ft. factory to Merle P. Hodges, Warsaw. Estimated cost $45,000.

Kan., Arkansas City—Keefe-LeStourgeons Co., R. T. Keefe, Pres., will build a 3 story, 60 x 125 ft. addition to packing plant, including refrigeration equipment, etc. Estimated cost $40,000. E. Moore, Arkansas City, is architect. Work will be done by local labor.

Mich., Detroit—C. H. McAleer Mfg. Co., 7401 Lyndon Ave, awarded contract for the construction of a 1 story factory for the manufacture of automobile polish to Austin Co., General Motors Bldg. Estimated cst $50,000.

Mich., Mount Clemens — Copeland Products Inc., awarded contract for the construction of a 1 story, 57 x 120 and 50 x 200 ft. refrigerator factory to Beyster & Olmstead Inc., 2-203 General Motors Bldg., Detroit. Estimated cost $50,000. Conveying equipment will be required.

N. H., New Durham—Allen Mfg. Co., plans to rebuild enamel factory recently destroyed by fire. Loss $25,000 to $40,000.

N. Y., New York—Paul Sowada, 369 Palmer Ave., Yonkers (light manufacturing), plans a 2 story, 44 x 103 ft. factory at 239th St. and Bullard Ave. here. Estimated cost $40,000. Edward Gower, 135 Fortfield Ave., Yonkers, is architect.

O., Bascom—Gem Manufacturing Co., plans the construction of a 1 story, 40 x 180 ft. factory for the manufacture of wooden toys. Estimated cost $40,000. Private plans.

O., Galion—Gledhill Road Machinery Co., E. C. Gledhill, Pres., awarded contract for the construction of a 1 story, 90 x 220 ft. factory to Theodore J. Schirtzinger, 1353 North High St. Estimated cost $50,000.

Tex., Houston—Hartman Interests, Inc., c/o H. W. Hartman, V. Pres., Gulf Bldg., will build a refinery. Estimated cost $2,500,000. Mark Lentz, Houston, is chief engineer. Work will be done by owner's forces.

PRICES • MATERIALS • SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions

SINCE LAST MONTH

DECLINING trends are more pronounced than they were a month ago in prices of electrical supplies. Power-plant supplies, on the other hand, seem less severely affected by reductions. The following materials were subjected to substantial price cuts: cement, rivets, linseed oil, BX cable, flexible cord, fuse plugs, and rubber-covered copper wire. Anti-friction and commercial grades of babbitt metal registered advances this month, as in September. The former is now 29c. and the latter, 34¾c. per lb., compared with 28¾c. and 34½c., respectively, a month ago, at New York.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft.	$0.46½
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less	70%

Air—Best Grade, Net

¾-in., per ft.	3-ply	$0.271	4 ply	$0.337

Steam—Discounts from List

First grade	59%	Second grade	60–5%	Third grade	60–10–10%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade	60–10–10%	Second grade	70–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

First Quality	Discount from list
Medium	45%
Heavy	30-10%

RAWHIDE LACING—Prices at New York warehouse:

Lace leather sides, 15 to 17 sq.ft., net, per sq.ft.	$0.45
Cut lacing, discount from list	45%

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure	40 %
Asbestos, air cell, for low-pressure heating and return lines: 4-ply	65 %
3-ply	67½ %
2-ply	70 %

PORTLAND CEMENT—New York, $1.60 per bbl., delivered by truck to site of job, without including charge of 10c. each for four returnable cloth bags. Packed in paper bags, 15c. above foregoing price but with no rebate, as on cloth bags.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 401 to 999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	6.50@9.00	13.00	13.00
Colored	5.50@8.00	9.00	9.00

WIPING CLOTHS—Prices per pound in lots of about six bales (600 lb.), for colored wipers, as follows:

New York	$0.10
Cleveland	.08
Chicago	.09

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.08	$0.091	$0.091

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

New York	$4.00
Chicago	3.75
Pittsburgh mill	2.75

Broken kegs, about 50c. higher.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	20.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	40.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	32@35

BABBITT METAL—Delivered in case-lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	43.50
Commercial, intermediate grade	34.75
Anti-friction metal, general service	29.00
Solder, bar	18.12½

COLD-FINISHED STEEL—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.10	$3.10
Flat or square	3.90	3.60	3.60

BOILER FITTINGS—Discounts from list at New York warehouse:

Copper ferrules	70%
Flanges	50%
Stay bolts	60%
Patch bolts	20%
Fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list, are for large mill-lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	64%	52½%	⅛ and ¼	31%	15%

LAP WELD

2	57%	45½%	⅜	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	⅛ to ¼	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	⅜	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2¼ and 2½ in..... .06 per cut
3-in..... $0.09 per cut
3¼ to 4 in..... .10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$22.00	$33.00	$55.00	$75.00
No. 12 solid....	32.00	44.00	66.00	91.00
No. 10 solid....	45.00	57.00	82.00	105.00
No. 8 stranded..	73.00	92.00	115.00	155.00
No. 6 stranded..	105.00	129.00	155.00	220.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net:

Size, Inches	GALVANIZED Conduit	GALVANIZED Couplings	GALVANIZED Elbows	BLACK Conduit	BLACK Couplings	BLACK Elbows
¼	$52.15	$3.15	$7.55	$47.31	$2.86	$6.47
⅜	52.75	3.78	7.60	47.91	3.44	6.52
½	53.93	4.42	7.72	49.09	4.02	6.64
¾	68.61	6.34	10.17	62.05	5.78	8.75
1	98.17	8.28	15.19	88.49	7.54	13.09
1¼	132.83	11.67	20.88	119.72	10.71	18.33
1½	158.82	14.46	27.94	143.14	13.26	24.52
2	213.68	19.35	50.82	192.60	17.77	44.55
2½	337.85	27.65	84.15	304.50	25.37	73.89
3	441.80	41.44	216.97	398.19	38.02	189.61
3½	557.58	55.61	474.82	505.14	51.05	414.40
4	681.33	69.30	549.07	619.19	63.60	479.25
4½	793.78	103.32	827.42	721.41	94.76	721.70
5	925.10	114.02	1150.87	840.74	104.61	1004.11
6	1200.61	164.80	1435.97	1090.67	151.12	1253.57

CONDUIT BODIES AND FITTINGS—Black or galvanized; discount from list:
Less than $15 list..15%; $15 list to $100 list..20%; $100 list and over..28%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$14.00
No. 16 cotton reinforced heavy		17.50
No. 18 cotton reinforced light		11.50
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		12.50
No. 16 cotton Canvasite cord		13.60
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$50.00	*55.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	78.00	*82.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discounts:

Less than one-fifth standard package	60%
One-fifth to standard package	65%
Standard package	70%

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.20
0–30 ampere, less than standard package, per 100	2.60

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.05

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.00	$6.10	$7.00	$11.90
12	5.90	6.25	8.60	15.10
10	8.10	9.10	11.05	19.60
8	11.30	13.40	15.90	27.00
6	.....	.....	23.10	.....
4	.....	.....	31.50	.....
2	.....	.....	42.00	.....
1	....	.....	61.00	.....
0	.....	.....	72.50	.....
00	.....	.....	83.00	.....
000	.....	.....	97 00	.....
0000	.....	.....	119 00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	⅜ In. Cap Key	⅜ In. Cap Keyless	⅜ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 25c. per lb.; in 100 lb. lots, 24c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 26c. per lb.; in 100 lb. lots, 24c. per lb.
Wire solder, in less than 100 lb., 24c. per lb.; in 100 lb. lots, 20c. per lb.
Soldering paste, 2 oz. cans..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:

Standard package	50%
Less than standard package	45%